PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

APRIL, 1940

A. PRESCOTT FOLWELL, Editor — VOL. 71. NO. 4 — W. A. HARDENBERGH, Asso. Editor

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TIMEWASTERS

"If I knew as much about calculus and analytical geometry as I do about football," says Sam Jenkins of West Virginia, "I might have solved that football problem." And on the third page of his letter he says: "If anyone ever sends in a set of nice equations for an analytical solution, I hope you publish them." No, Mr. Jenkins, those equations make our printers peevish, but we'll forward them to you if one of our really professional timewasters will shoot them to us; spring fever has us, and we're not writing equations for anyone.

The "Road Builders News" has burst out into a whole flood of problems, running about 30 per issue; we hope they keep it up. We'll just draw on them for this month's supply, though thanks to our little group of serious thinkers, we really have an adequate supply of our own on hand.

What Road Men Think About:

Can you make three cuts and cut a pie into eight pieces?

If in five years my age will be twice what it was ten years ago, how old am I now?

A man bought 100 postage stamps in the denominations of 2, 3, 5 and 7 cents. If he spent an even $5, how many were there of each?

The sum of two numbers is 22, and half the difference of their squares is 22. What are the numbers?

"Elementary, my dear Watson."

—W.A.H.

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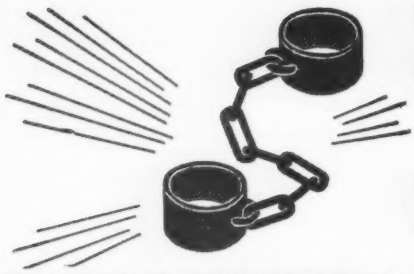
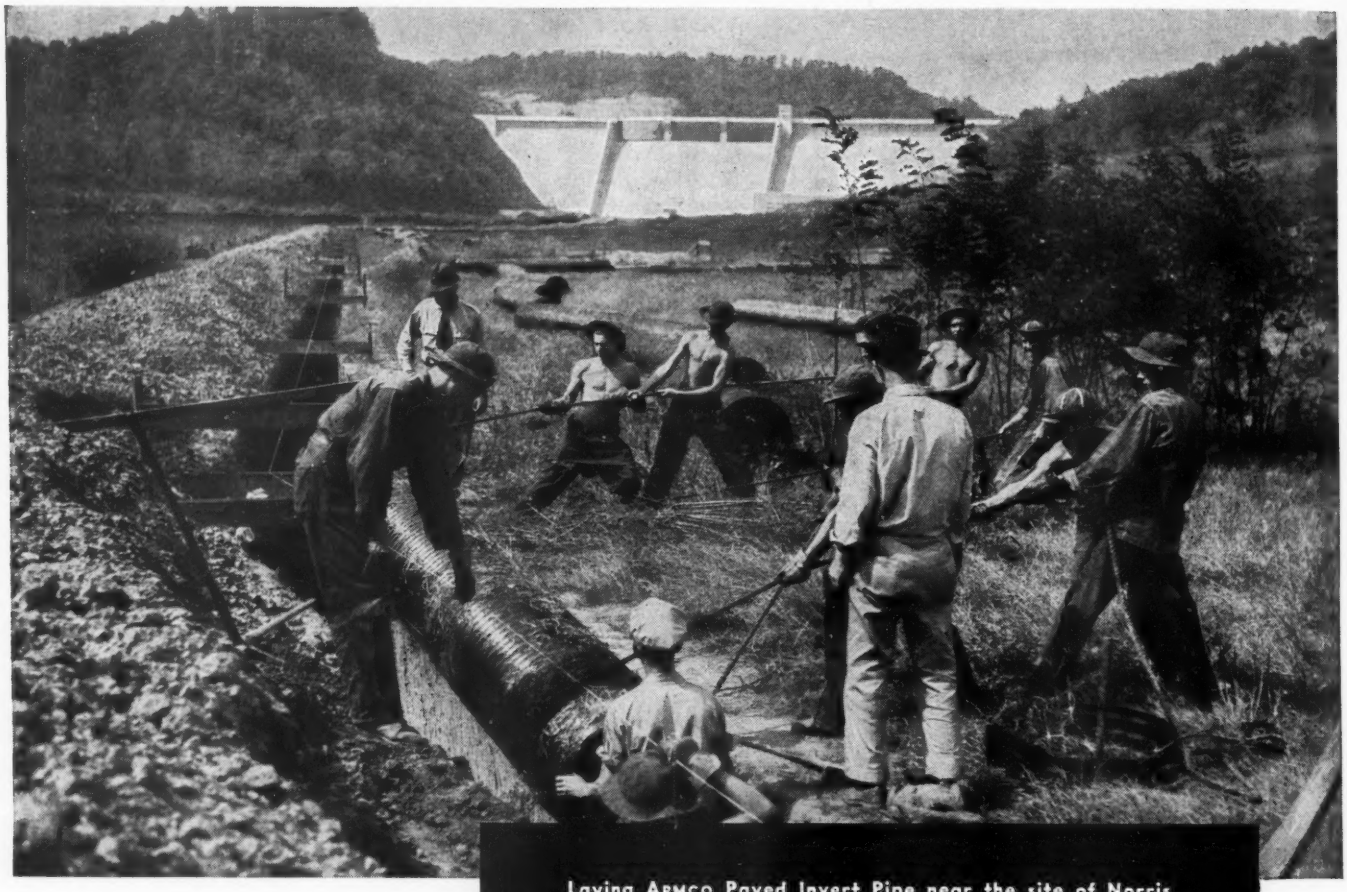


IT SHACKLES EROSION and Prolongs Pipe Life!



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When writing, we will appreciate you mentioning PUBLIC WORKS.

The Editor's Page

Municipal Construction Without the PWA

"This office has about the usual number of projects in this teritory," says a mid-west consulting engineer in a letter to the Editor. "These projects are smaller in cost than those which were inspired during the past few years by PWA financial assistance. However, they represent a very solid type of business and cover municipal improvements actually needed. Construction costs on lettings are about 22% below the 1939 PWA levels for similar jobs. Engineers, contractors and city officials are very happy to be rid of the quantity of red tape encountered where Federal assistance was involved. WPA is very active in the promotion of municipal projects but for the most part the WPA projects are those which absolutely could not be financed independently by the communities in question. In other words, they are located in the smaller communities where the financing possibilities under the restrictions of the code are limited."

This engineer then goes on to list the costs on some fourteen projects on which he has been retained, and to mention several others where costs have not yet been determined. The projects involve an expenditure of approximately $450,000, not including WPA funds, which are to be contributed on five of the projects.

It would seem that not all the necessary work has been done yet and that construction will still go on, even without the PWA.

Some of the Pros and Cons of Governmental Housing Programs

The program for the betterment of housing conditions is a highly laudable one if it does not impose upon the taxpayers a burden that is too heavy to be borne. The Federal Government has announced that its cost on new housing projects has been reduced to about $6 per month per family. In addition, municipalities have generally been obliged to waive taxes for a long time to come; local funds may also be contributed. The net result of all this is that taxpayers are providing a considerable amount of money for the benefit of a small proportion of the population. We do not recall the exact figures, but we seriously doubt if any program that can be carried out will improve the living conditions of 5% of the population; and for this improvement all the others must pay.

As much as we would like to see everyone in a nice new house with modern plumbing, heating and other equipment, we cannot feel that this present program is on a sound basis. The fundamental facts that must be faced are that in the end there can be no favored class, but that everyone must pay his own way, and that the only solution for improved housing is to encourage and cooperate with private organizations to the end that such buildings will carry themselves with a slight return on the investment. One of the biggest difficulties in governmental finance right now is the burden of mandatory expenditures that must be met, with a resulting burden on the taxpayer and a cut in many essential services. We believe that a housing program can and should be worked out without any subsidy to a small proportion of the population.

Should Municipalities Hire Only Licensed Engineers?

"Why don't you advocate the obligation of municipalities in supporting state laws by the employment of registered engineers who have been licensed by the state in which they live?" So writes one of our subscribers, and we agree with him. If a state has a licensing law that regulates the practice of engineering, that law certainly ought to apply to anyone who is employed by a subdivision of that state. There may be problems, such as the part time or occasional employment of an unlicensed engineer, which are difficult to solve on a relatively small job. Perhaps this could best be met by the general requirement that such employment be under the supervision of a registered engineer.

There isn't much use in setting up standards that require engineers to work and study to meet these standards, and then letting sub-standard men, or men who have not taken the trouble to qualify get the work. An engineer is supposed to be a little more efficient than the average non-technically trained man, but even he has not learned how to eat steadily without having a job.

Without entering into any discussion as to the relative merits of registering or licensing engineers, we certainly feel that where a law of this type is in effect, municipalities and other political subdivisions should obey it in spirit as well as in letter.

Designing Low-Cost Highway Grade Crossings and Intersections

Little has appeared in technical magazines on the design of low-cost highway intersections to minimize accidents and encourage the flow of traffic. A good deal of space has been given to clover-leaf and similar types of high-cost modern intersections. We would like to see a study made of safe and high-capacity intersections where overhead and underpass structures cannot be used, either because of cost or for other reasons; but principally we would like to see designs that will meet the demands of the average city and county engineer for road intersections where there is considerable traffic, some accidents, a need for improvements and not much money.

About one-fourth of the rural accidents occur at intersections. Not all of these are preventable, but some at least are. The development of principles governing the design of intersections, with special emphasis on rural and small city conditions would be a distinct contribution to highway safety. Some work already has been done by the Association of State Highway Officials and the Bureau of Public Roads; more would be welcome.

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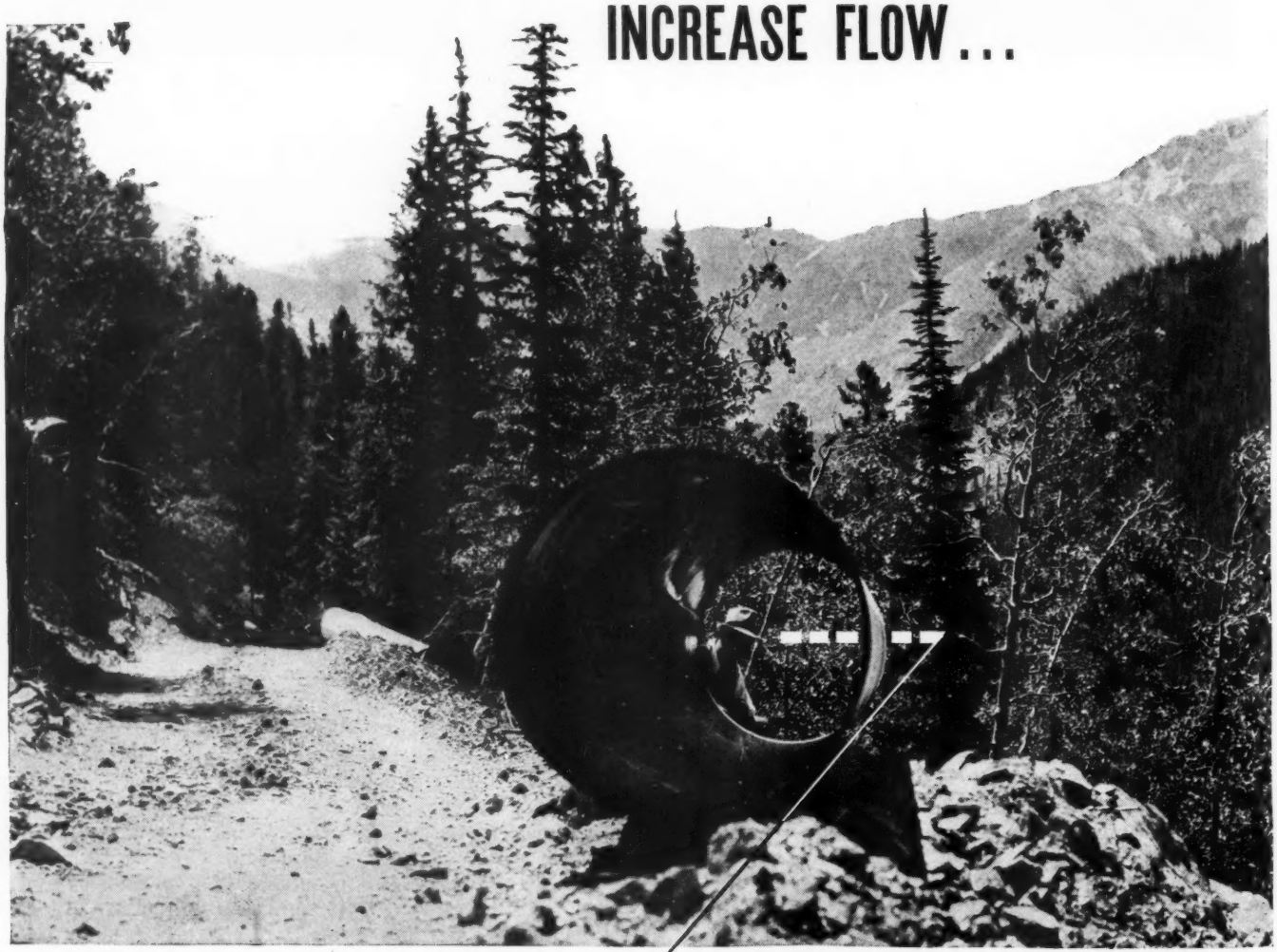

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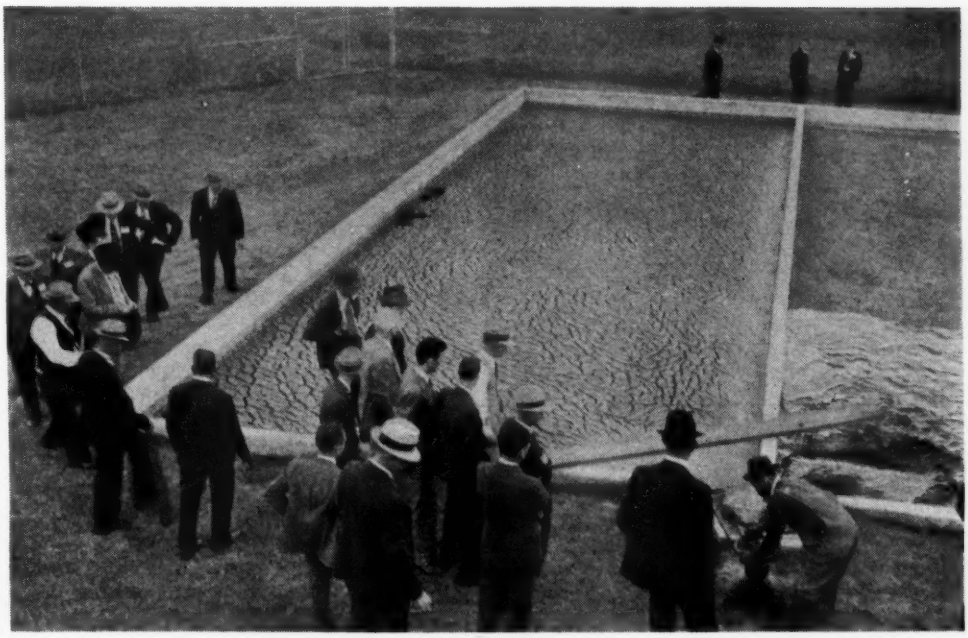


A Georgia group get a practical demonstration in drawing sludge

Short School Instruction for Superintendents and Operators

Certain elements are essential in carrying out a sound instruction program: A well planned schedule, careful preparation, good instruction and a school atmosphere are among them

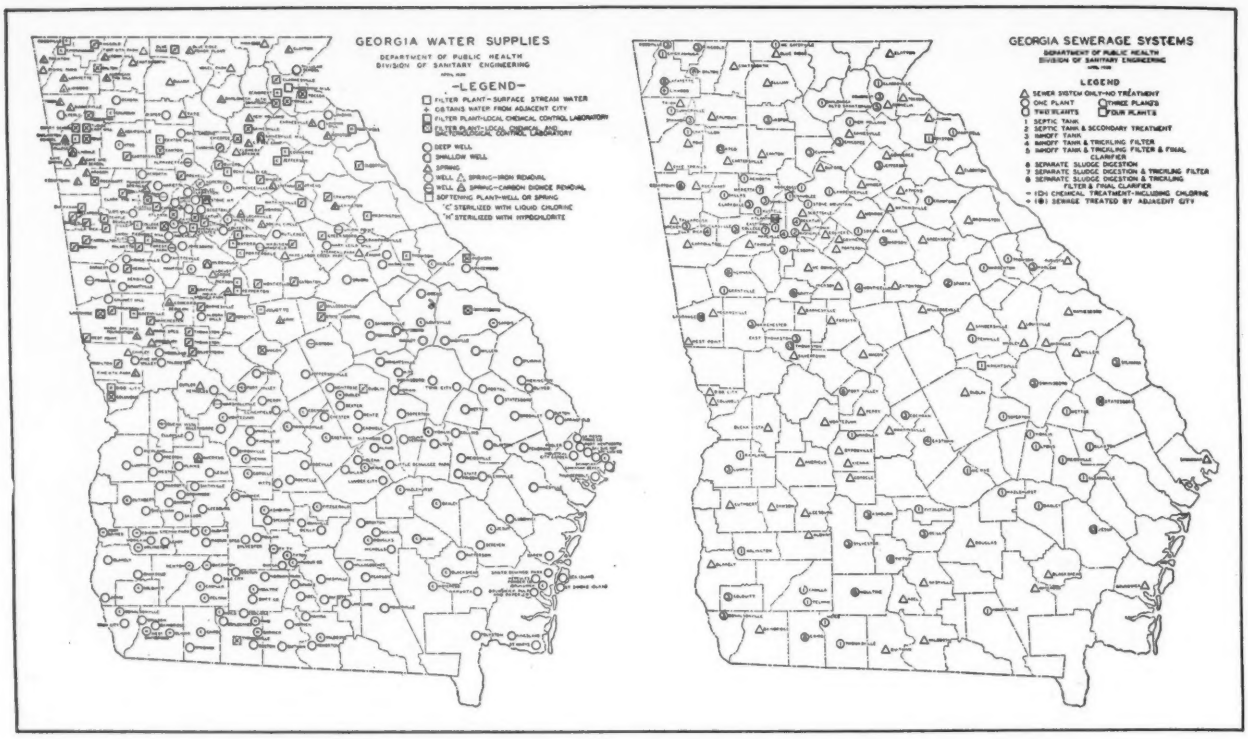
By W. A. HARDENBERGH

MANY short schools for water and sewage plant operators and some schools for highway employees are in operation. Only a few of these schools are really effective in accomplishing the purpose for which they were ostensibly and primarily created—advancement and improvement in the skill of the attendants and a better return to the public for the monies spent by or under the direction of these men.

The factors that work for, or contribute to the lack of, success of such schools are largely intangible and therefore difficult to put into words. This article is based on considerable personal observation of a number of schools and participation in some of them; on a lengthy interview with W. H. Weir, who has been so largely responsible for one of the most successful of all schools—that held by the Georgia Water and Sewage Association; and on the writer's personal experience in conducting for the past 13 years the schools operated by the U. S. Army for training reserve officers in Military Sanitation. For the most part, this article will describe and discuss the methods used in Georgia.

The first step in any course is the planning and the first consideration is the men who are to be trained, their background, previous experience, technical education and the work they are to be fitted for. These items actually form the basis of the course and consideration of them requires analysis and clear thinking.

There will always be wide variations between the best trained and the poorest trained in any group.



These charts show the present status of Georgia water supplies and sewage disposal systems.

Adequate consideration must be given to providing training for all, but the lowest grades must have primary consideration. It is better to provide both basic and advanced training, but where it is difficult or impossible to do so, instruction subjects must be provided for each group, with greater emphasis on those that require training most.

Preparation for any course must include (1) a study of the experience, training and needs of those who will attend; (2) the drawing up of a schedule of subjects to be covered; and (3) selection of men to present these subjects.

Carrying out of the prepared course to be most effective requires (1) selection of instructors on the basis of their knowledge of the subject and their ability to impart that knowledge; (2) a degree of supervision of the material to be presented to insure that the data will (a) cover the field that is intended to be treated by this particular lesson and (b) fit into the general picture presented by the other speakers.

In the military sanitation instruction, no one is scheduled as an instructor unless he has previously demonstrated his ability to instruct, generally by actual demonstration. He is assigned a definite subject; unless he has served previously, he is furnished with an outline showing the material he is to present. He cannot read his paper but must speak from notes, and is held rigidly to a time schedule. He is often or usually required, to go over what he intends to say, in advance, in a conference with the chief instructor. The new schools started in the past two or three years have been operated on a schedule prepared in advance, by selected instructors furnished with previously prepared outlines of each of the 40 to 45 subjects scheduled. These schools have been highly successful.

Field or laboratory work, preferably both, are essential. These must be carefully planned and the exhibit program of work must clearly tell the story that it is intended to tell.

In discussing the Georgia School, Mr. Weir presents the following outline for consideration and as a basis of the work.

1. A thorough study of the problem.
2. Organization, planning and instruction.
3. Attendance and means of getting it.
4. Teaching methods.
5. Results.

The Problem

In considering the problem of making the school an effective force in training the men engaged in water and sewage work, the general situation is important. In Georgia, for instance, there are many small plants, few large ones. Pay is not very high and few of the men are technically trained. The time of the meeting has some weight and should be studied. The part this school may play in licensing and certification should be carefully considered.

Organization of the School

The resources and facilities for training in connection with all short schools should be surveyed and studied, and all assets and liabilities weighed, such as local or state facilities, local laboratories and plants that might be usable, colleges, etc.; also any facilities that are needed and can be created. For instance manufacturing firms may contribute models.

The program should be planned, Mr. Weir emphasizes, for maximum value and practicability, especially as to the elementary phases of instruction.

Selection of instructors is highly important. In Georgia, instruction is carried on principally by the staff of the Sanitary Engineering Division of the State Department of Public Health, aided by faculty members of the Georgia School of Technology, the better men among the operators, and by one or two outside persons. Special attention is given to providing a place in the program where attendants have an opportunity to speak. The purpose here is two-fold—to get one or more new qualified instructors each year, and to give

the operators training in talking on their feet, which may be advantageous when they return to their home town.

The creation and maintenance of a school atmosphere is important. The accomplishment of this is probably one of the intangibles already mentioned. The attitude of the director and of his principal assistants and their ability directly to influence or dominate the school are important. There must be a leader; the assumption must be that men come to learn. Noticeable drinking or having a "good time" not only subjects the school to criticism, but reduces attendance on the part of those who wish to come to learn.

A supporting organization (in Georgia, the Georgia Water and Sewage Association) is almost a necessity. Its officers should be representative of its membership and should be able men, interested and cooperative. The association should not be a figurehead but a strong force working with the state department of health.

Improving the Attendance

In the end, attendance depends upon the value of the instruction given at the school, but measures to increase attendance are desirable. In Georgia the principal steps employed are of three types: First is the creation of the desire to come to the school, which desire is based on the craving to learn to do the work better, to pass the licensing or certification examinations and to become fitted for better paying positions. Each year, special attention is paid in the school to new plants and new operating features, data and equipment.

Publicity and promotion regarding the annual school are always carried on. As the department engineers visit the various plants, efforts are made to interest the operators. The Association maintains close touch with all operators and also edits a bulletin in which instructive material is published.

Contacts with and responsibility of local officials are stressed. Contacts are continually made by the department engineers with local officials well in advance of the school, letters are sent to mayors, managers, etc., enclosing return cards for registering the men, stressing the fact there is no cost except for room and meals. When required, these letters are followed by "casual" calls or by personal letters. For the annual dinner, special efforts are made to have mayors, managers and superintendents (those in charge of the operators) attend.

Thus attendance is fostered by creating a school atmosphere, providing carefully planned instruction of a needed nature, and cultivating both the operators and the higher officials who often control the money. However, many operators attend at their own expense.

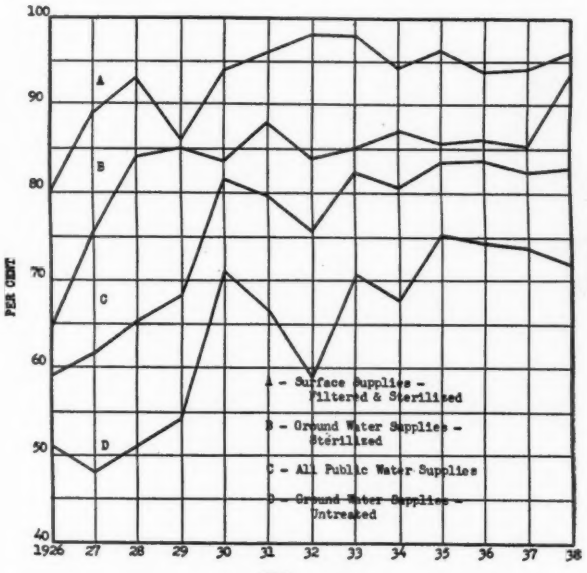
An outdoor school in Georgia

Sound Teaching Methods

Teaching is not accomplished by reading prepared papers. In the Georgia school, plant inspections, charts, blackboards and pieces of equipment help the instructors to tell their story. Emphasis is placed on those things the operators can use in their daily work. The Georgia Water and Sewage Association gives tests for certification and the course of basic instruction each year covers all general questions on these tests.

As a rule, subjects are considered and discussed in advance with instructors in order to assure that each will be covered properly. This advance preparation is considered quite essential.

Any program for instruction should include advance discussion of the following: (a) Teaching vs. reading



Percentage of Georgia water supplies meeting Treasury Dept. bacterial standards

of papers; (b) classroom and laboratory work combinations; (c) practical work and plant observation combinations and coordination; (d) preparation of teaching material; (e) provision for basic and advanced instruction; and (f) the utilization of and policies in regard to commercial equipment and sales engineers.

After the first two or three sessions, it is almost essential that a program of advanced instruction be made available. However, in any school, the basic course is primary and fundamental and must be maintained. The number of advanced courses that can be given is limited but a wider and more frequently changed curriculum is possible.

Policies in regard to the use of sales engineers must be determined in a clear cut manner. There is no place in a school for the dry, long-winded reader of technical papers who sets out to prove the advantages of his method or product. On the other hand a sales engineer should know more than anyone else about the uses of his equipment and how to operate it. If he will use—to employ a slang term—5-cent words to the complete exclusion of $2 words and will avoid any form of sales talk, he can be a valuable instructor. In the end he too will probably gain by such a procedure.

In this same connection, entertainment by salesmen of the men attending the school should be strictly limited. Displays of equipment may be permitted with

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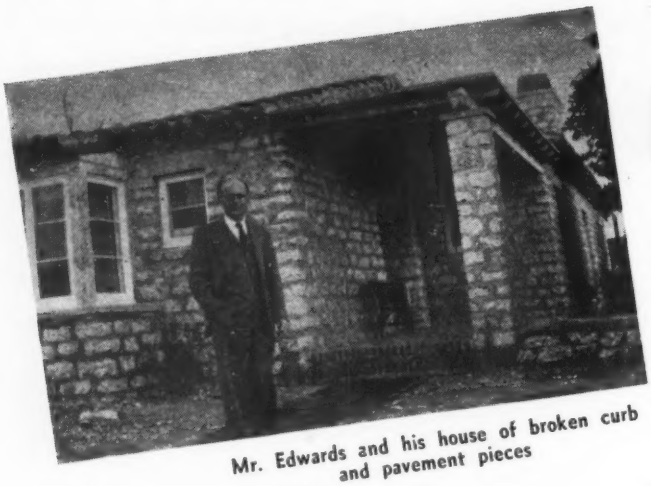


Mr. Edwards and his house of broken curb and pavement pieces

Designing Flood-Proof St

By HARLAN H. EDWARDS
City Engineer

Typical storm water outlet

A curb outlet

A reconstructed intersection with high curb

TO ONE whose idea of a flood has been gained by experience in the lowland areas where sluggish streams merely increase in volume and overflow their banks, a flood in a mountainous area is a fascinating and sometimes terrifying thing, demonstrating most forcefully the tremendous power possessed by swiftly flowing water.

Claremont, California, the home of Pomona, Scripps and Claremont Colleges, located on the alluvial slope below the Sierra Madre Mountain range, some 40 miles northeast of Los Angeles, was normally thought to be safe from flood waters due to its position high up on the slope, some three miles from the mountains. Actually, however, it is on the active portion of an alluvial fan or cone formed by the stream discharge from San Antonio Canyon, a steep, rocky area of about 21 sq. mi. extending upwards almost 8,000 feet to the winter-snow-capped top of Mt. San Antonio, commonly called Mt. Baldy; the active stream bed below the mountains lies along the high edge of the cone, ready to cut its banks and dash down the steeper side slopes. This stream is normally dry outside the canyon, the usual flow being absorbed by percolation into the coarse rock and gravel near the base of the mountains; but a tremendous flow, estimated at 25,000 second-feet, suddenly roared out of the canyon as the result of a cloudburst occurring high up in the mountains after a week of heavy rain. Carrying a heavy load of great boulders, this flood reduced to bits tall trees, buildings and everything within the canyon. Rocks too large for several men to move were whisked away. Any efforts to control and direct the flow were ineffective.

It was this silt and boulder-laden water that cut its way out of its original (though constantly changing) channel and roared down upon Claremont, depositing thousands of tons of rock and gravel upon the flatter

A type of box culvert outlet

Streets to Carry Storm Water Flows

Following heavy flood damage, the streets and storm drainage system of Claremont were redesigned to prevent damage by future floods

What was left of College Avenue after the flood

areas there. Gathering fresh impetus on the steeper streets, it cut through or undermined pavements, curbs and sidewalks, and created new streambeds and small canyons in spite of all Claremont's citizens could do.

Had it not been that large forces of men were immediately available through the WPA by reason of the previously planned "Emergency Project," losses would have been much greater. Red tape was cut and men, materials and equipment were quickly brought into action, apparently under orders to do the job and talk about it afterward. Within two hours after orders had been given, some 250 men were at work along the stream; materials were on the way for sandbags, rock-and-wire embankment protection and jetty construction; and foremen experienced in this work were directing operations. Permissible hours of labor and written authorizations were not considered while danger existed. What all this meant to our little city of 3,000 was realized fully by only the few of us in authority who appreciated the gravity of the situation, who knew how quickly the city's small reserve had been wiped out and how impotent our available forces had been against the flood.

Curb is 20" high at corner; 6" two blocks away

Following the removal of debris came the problems of reconstruction. Surveys, plans, estimates, preparation of WPA reconstruction project requests—all involved their own problems which had to be solved within specified times.

In planning for the new streets, lessons learned from the flood were applied. New street profiles involved readjustment of old street grades wherever possible to eliminate abrupt changes of street slope (because piles of debris will settle out on the flatter portions) and to establish, instead, uniform or gradually changing grades with corresponding street widths or curb heights to provide adequate gutter capacity. Longer-radius curves, with higher curbs on the far side to prevent overrun by heavy flows, and high curbs placed simi-

larly on the low side of street intersections were provided.

Prevailing slopes in the Claremont area are 3 to 4% on the north-south streets, and 1% or less on the east-west streets. Wherever debris-laden water flowed across a flattened street-intersection the decreased velocity tended to deposit the coarse rock which, again slowing the current at that point, caused a further deposit of gravel and sand, tending to divert water across the flatter intersecting street onto adjoining property. In reconstruction, the prevailing north-south grades were carried unbroken across street intersections using as flat a crown on the waterway street as possible, to give the maximum water capacity — generally 2″ to 3″ crown in a 36-foot paved width. The flat crown was used in place of an inverted crown (which would have been better for its cross-riding qualities and for capacity) because dry-weather flow of escaped irrigation water in the center of the street would have been detrimental to traffic. Intersecting pavements were warped down or up to meet the gutter line, taking care by adjustment of grades to avoid any possibility of flow around the upper corner of the intersection.

Wherever a break occurred in the continuity of the curb, as at street intersections or private drives, the swift flow spreading out would pile up against the far corner of the curb tending to override it, consequently a curb as high as 3 feet was needed at some intersections for protection in time of heavy flows. Private drive openings were kept to a minimum and where used, the curb was slotted to permit the use of a plank filler along the curb line when needed.

Curbs on cross-slope streets also were designed to fit conditions. Such curbs were generally kept at the same level on the high and the low sides of the street, providing a shallower gutter on the high side for low flows, and full capacity between curbs for heavy flows. Where intersecting flows were encountered, however, such as from streets ending at the cross-slope highway, curb heights on the low side were increased accordingly —in one place being increased from 6″ at the point of flow to 20″ at the point of intersection of heavier flow, continuing thus to the point of flow discharge. This increase in height was necessitated not only by the possibility of overrun at the input point but also to the gradually increased water concentration on the low side as the street warped into the water-carrying roadway causing the flow from the high gutter to spill over into the low one.

Street grade changes were largely in the less-developed lower part of the city, and varied from a slight fill backed by heavier fill on the property adjoining (by request) to as much as a 4-foot cut below surrounding property. In place of objecting to such a cut, property owners generally welcomed it as an added benefit, protecting them to a greater extent from another flood. Grades on tributary streets were kept lower than those of the principal flow-ways to avoid carrying and depositing debris.

College Avenue after reconstruction

New designs were developed for storm water inlets which provided gradual changes in direction of flow in and out of the sewer to maintain velocity and to avoid run-by and eddy troubles so prevalent in general city design. In other words, the principles of streamline design, so much talked about but little used on street work, were applied with effective results.

Storm water inlets of the conventional type normally consist of openings in the curb face through which water on almost level streets can drop directly into catchbasins or sewers. Velocity-diminishment through such inlets is of minor importance on such streets normally, though major consideration in times of heavy flow due to reduced capacity by swirling or eddy currents at the entrance and in the inlets. Such inlets become almost useless along streets of perceptible grade where water flows with decided velocity, because of the certainty that such flows will run right by the opening.

Storm water inlets, consequently, on streets of definite slope should be so designed that the water flows with undiminished velocity on curves of long radius (both vertically and horizontally) into the sewer. Such inlets must have long openings through the curb, the length being dependent on street grade and volume of flow and being sufficient to permit the flow to make the curve smoothly. Care must be taken not to have a decided cross slope into the opening because of the personal hazard of one stepping down and turning an ankle unexpectedly. In other words, the inlet is a sort of long funnel having as the outlet the sewer or its branch from the "Y" of ample capacity to carry the load.

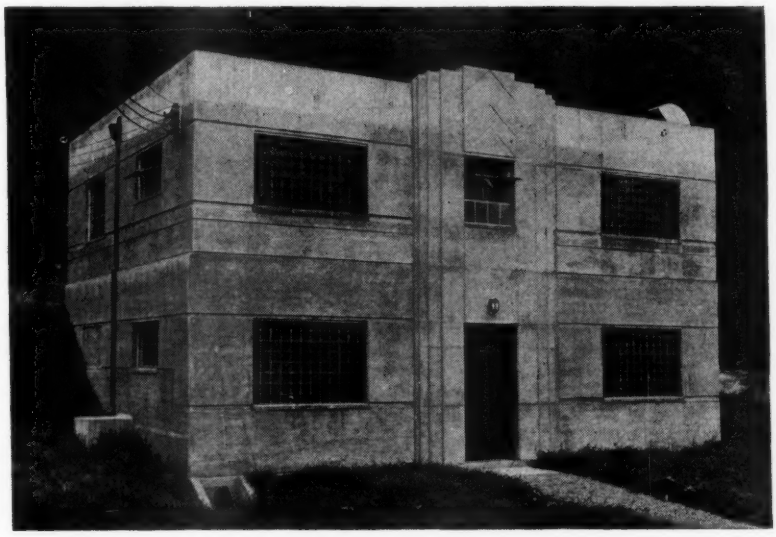
Pavement design brought up more problems. Very limited funds precluded the use of concrete or similar pavement types for streets with heavy flows. Fortunately the subgrade generally was a well-compacted gravel, providing an excellent foundation support for an asphaltic armor-coat type of wearing surface which was relatively inexpensive and easy to lay.

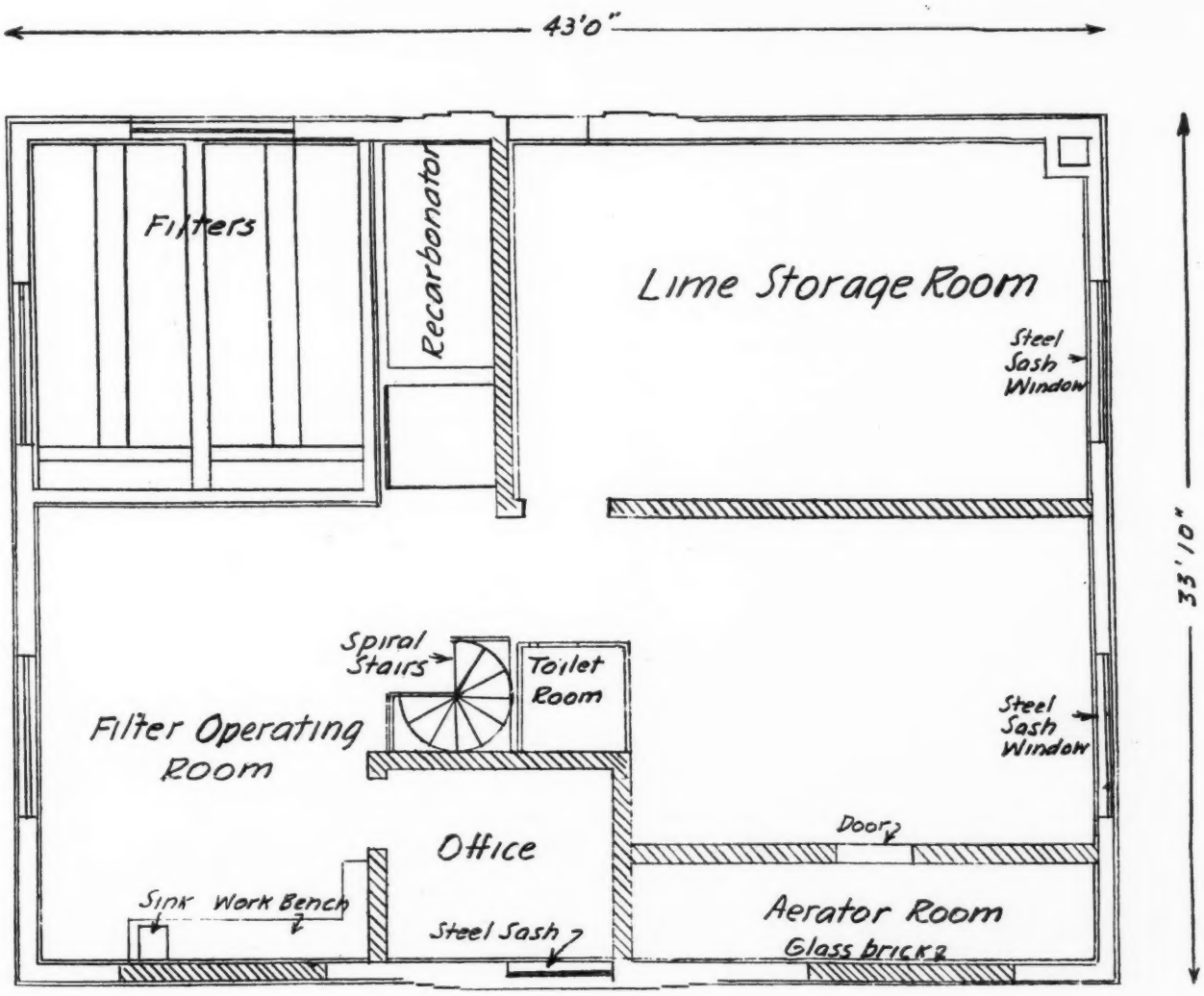
In deciding whether this wearing surface should be of the premix type or of the penetration type, many pavements were examined in other cities similarly located and similarly subjected to heavy flows. Since all available literature on pavement types was apparently silent on the relation between cost, pavement type and water carrying ability on various slopes, final decision depended largely upon observation of failures. For its low cost and apparent dependability, the pavement selected was a 1½″ penetration asphalt-macadam, sealcoated, using Bitumuls asphalt emulsion entirely on some streets, and hot SC 6 followed by 95+ or Grade E asphalt on others, sealed with Bitumuls in both cases. This penetration type was selected because of its apparent toughness, because of its being keyed into the subgrade by the action of the roller (instead of being applied as a blanket covering as is the case of plant mixed types) and because of its comparative watertightness, reducing the chances of water getting through the surface to soften the subgrade or to hump or float the surface by hydraulic action. Simplicity in construction and equipment available, again favored the type selected, for a smoother, better-riding pavement could be secured with inexperienced WPA labor by blading the rock layer with a grader, followed by compacting and keying using an old-type 12-ton Austin road roller, than by other methods.

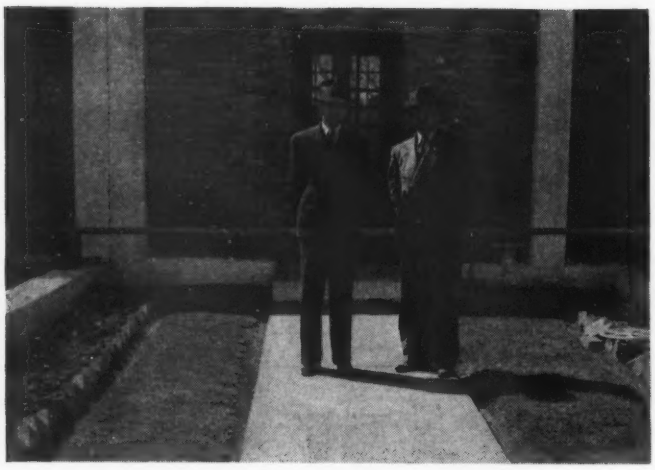
An Attractive Building for a Small Water Plant

The first in a series illustrating some modern and attractive small plants

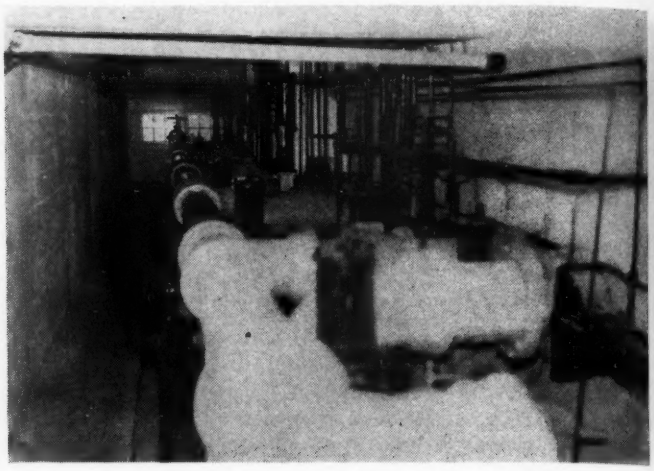
The water softening plant at Guttenberg, Ia., built for the city by Howard R. Green Co., Cedar Rapids, Ia., Engineer; L. S. Barber, resident engineer; Arthur S. Mathis, West Des Moines, Ia., contractor. An architectural concrete structure with precast concrete floor joists. Photo furnished by Portland Cement Association.







C. J. Phillips (left), Asst. Supt., and Mr. Lloyd



The pipe gallery is an important part of the plant

Operation Details for a Small

By J. M. LLOYD
Water Works Superintendent, Tyler, Tex.

FROM observation, I have noticed that small town filtration plants are not, generally, as well equipped as those in larger town. Small towns are not able to pay the operators salaries that are commensurate with the work that in reality safeguards the health of the community. That is, they cannot afford to hire operators who have sufficient knowledge of mechanics and chemistry to understand why and how things are done to turn out a good effluent. In the past few years the State Department of Health has done much towards training these men and towards making them operators of first class standing.

Water for the City of Tyler comes from a lake covering 177 acres, with an average depth of approximately 10 feet. The water shed area is 5 sq. miles, most of which is wooded with very few inhabitants living on the water shed. This lake is very shallow around the shore line, and has a great deal of vegetable matter, such as flags and lily pads.

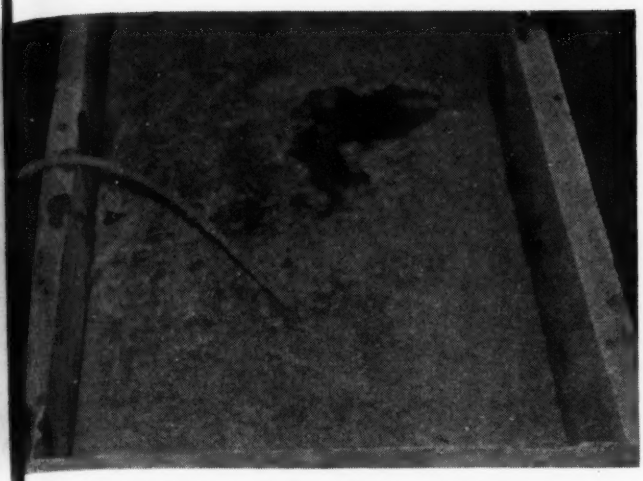
The water shed is carefully patrolled each week, and dead animals, dumping of trash, and other objectionable conditions are immediately cared for. This patrolling, with authority from the State Board of Water Engineers to conduct and police these areas, has been of much value to us in being able to enforce and stop pollution hazards that have developed from time to time.

Through the aid of the Tyler-Smith County Health Unit and the sanitary engineering department, sanitary pit toilets have been provided for all houses on the water shed. These houses are inspected from time to time to be sure that no diseases exist, and to insure that all persons have been immunized against typhoid fever. I believe this to be of great value for any plant and recommend that all families who could pollute any water supply be immediately immunized.

We have found that the quickest method for eliminating both taste and odor is to watch the condition of the lake. The lakes in East Texas, especially older lakes, are high in organic matter and manganese. Our particular lake, being shallow, is partly covered with flags and lily pads. It has been almost impossible to rid the lake of this growth, even when the lake is low. We have tried burning with oil, cutting the lily pads at the bottom, and have found that no treatment has been entirely effective. The only method that we have been able to apply with effectively is to dig underneath the growth itself and take out all of the roots. In this manner we have been able to eliminate most of the flags. We have found that microscopic organisms settle to the bottom of the lake and the shore lines during the fall and winter periods; and early spring rains bring silt which settles over this vegetable matter. Then when the spring lake turnover occurs the lake has a high hydrogen sulfide content and low dissolved oxygen. During this period of lake turnover the water has a very obnoxious odor and a dark color, in our case caused by manganese and organic matter. Remedies for these troubles will be discussed later.

Operation and Care of Filters

Tyler has a well designed filtration plant with five 650,000 gallon International filters. During the spring and summer months the filters are overloaded and become quickly clogged with mud balls and algae-manganese balls. This is a term we have coined for our particular plant. In 1936, the first time the filters were gone into, some of the manganese balls were two feet in diameter. We took the sand and gravel out of the filters and thoroughly washed it. The following summer we found that we had just as much trouble. That winter I ran many tests and found that hydrochloric acid was the best cleaner that could be found to eliminate the brown manganese stains and growths on the sand particles, so we began treatment with strong chlorine solution, as high as 250 parts per million. Each filter was treated for a period of ten days, and when the filter was washed, practically all the manganese balls broke up. Continued washing and re-washing of the filters eliminated practically all of the manganese and mud silt from the filter bed sand. We have



Filter being treated with chlorine: Note scum

Experiences in plant operation and in the use of heavy chlorine applications for taste and odor control, plus good advice for all plant operators

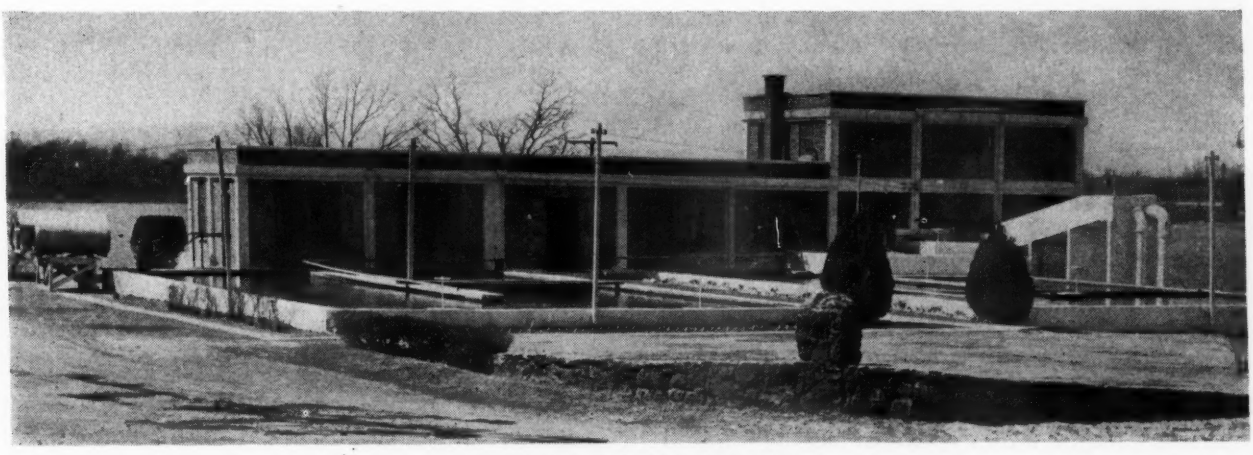
Water Treatment Plant

determined that operation cost has been reduced by eliminating the amount of wash water required to an average of 1¼%. The results indicated that continued strong chlorine treatment once a year would give a satisfactory operating condition on the filters for the rest of the year.

I have observed that in most plants, including some of the larger plants, the operator on duty will show you the entire plant but hesitates on taking you to the filter gallery. Once a year it has been our practice to take down all of the controllers and operating mechanism of the filters and observe carefully their condition, cleaning out all of the accumulated rust, and replacing worn parts when necessary. It has been a standing rule in our plant to stop all leaks immediately when they show up in the filter tunnel.

All pumps and motors in our plant are checked at least once a year. Each pump is taken out of service and impellers and all bearings are examined and checked for clearances and wear. It has been our practice to keep smooth sleeves on the shafts so that no excess waste of water will pass through the packing glands during the periods when these pumps are needed. The windings of all of the motors are blown out each year with compressed air to eliminate all accumulated dust, which might cause a hazardous condition during the summer period, especially if any oil is leaking through the bearings into the windings. We have determined that the proper time to overhaul the pumps and motors is during the winter period. After each pump has been taken out of service for its respective overhauling and put back in service, it is tested for alignment, running condition and capacity. If it proves to be in good operating condition, the pump and motor are carefully painted. It has been found that by a yearly inspection of all of the pumping equipment we have been able to reduce the operating cost of the plant in power consumed alone sufficiently to justify this inspection, while at the same time we have maintained a fairly neat appearance in the pumping station.

Our worst enemy is taste and odor. Prior to April, 1938, we used the following treatment: Aeration of the raw water, flocculation with aluminum sulfate, chloramine treatment, lime treatment for pH adjustment,



General view of the Tyler filter plant

followed by post chlorination. We found that even with this treatment we were unable to eliminate tastes and odors. Complaints came in from the general public so rapidly during the spring and fall periods that all of the telephones in the City Hall were constantly ringing, and accusations were being made that horses and possibly cows had fallen into and been drowned in the lake. We began treating heavily with dosages of copper sulfate on the entire lake, killing quite a few fish. We found that we still were not able to eliminate the taste and odor. Chloramine treatment was eliminated but we had not yet found the answer to eliminating taste and odor. As a last resort, we began superchlorination. During this period, we used a rate as high as 7 ppm. immediately after treatment with the coagulant. We found that no taste and odor could be detected. Careful tests showed that chlorine had proved to be the oxidizing agent towards eliminating all the microscopic life and organic matter in the water. Treatment with 3 ppm. at this time aggravated the condition. In other words, this point might be termed the killing point. In the last stages of superchlorination, or the point where oxidation is complete, there was noticed to have been a very faint chlorine odor only. We have set up our charts on this basis and have found that the best way to eliminate the taste and odor is to have an 0.8 to 1.0 ppm. of chlorine residual in the water just prior to filtration. During the winter periods superchlorination may be maintained with as low as 2.5 ppm. During the early spring periods we have found it to be worthwhile in slowing down microscopic life and algae growth to treat the entire lake with 0.2 ppm. of copper sulfate. Once a month during the summer period copper sulfate is added around the intake.

We have found that this type of treatment has insured a safe water and at the same time has eliminated tastes and odors, and to some extent oxidized most of the manganese in the water, giving us longer filtration periods by preventing growths on the sedimentation basin walls and on the filters. We have found that the cost of this type of treatment is not exorbitant, provided chlorine is bought in ton containers. Additional care of the lake should be maintained throughout the year, observing algae life through a microscope and determining exactly what types of algae and microscopic organisms are giving the trouble. Constant vigilance over the raw water is maintained at all times, and we have been fortunate enough to have had no complaints on taste and odor since April, 1938.

Picnicking and fishing around the intake is prohibited. When we first began placing markers stating that no fishing or picnicking was allowed within one-eighth mile of the intake or inside the markers, we expected to have a big fight on our hands with the fish-minded public. We were pleasantly surprised that no complaints occurred when the people were told why these markers had been placed, and that it was for their own benefit. I believe that a major factor was the statement on the signs that no picnicking or fishing were allowed within designated limits by recommendation of the State Department of Health, enforceable by the police department.

I have observed that most small town filtration plants maintain a laboratory. I require the operators in our plant to run chlorine residual tests hourly on the treated water, alkalinity tests on the raw and treated water, and put on bacteriological samples for testing twice daily. It has been our practice to run efficiency tests on each filter once a month to be sure that each filter is in good operating condition, and to be insured that no possible contamination is coming from improper filtration. Most of the tests are simple, and operators are easily trained to be able to carry them out satisfactorily. I have noticed that the operators have taken additional interest in their work since they have their "C" surface license certificate. In our particular case, one man has successfully passed and received his "B" surface license certificate. It is my opinion that the average operator will take more interest in the filtration plant if he be allowed to assume an average responsibility. He is trained to be able to take care of emergencies that arise without undue confusion, and also to be thoroughly familiar with the care and operation of the chlorine units, dry feed machines, and measuring devices. He is also trained to be familiar with the entire piping layout of the plant, and to know the exact location of all valves and what each valve, when closed, will shut out.

If the clear wells are covered and chlorine treatment is used, an inspection every two years should be made to determine the condition of the walls and of the roof. Sedimentation basins are inspected after each washing.

The general appearance of the small town filter plant is usually not equal to that found in the larger cities. We have received benefits of labor from the N.Y.A. recently, and they have done much towards beautifying the entire plant. I believe that it is possible for most of the small towns to secure this aid at small cost, this cost including furnishing the necessary tools and shrubbery to permit the boys to terrace and plant.

This material is slightly condensed from a lecture by Mr. Lloyd before the 1940 Texas Short Water and Sewage School.

Movable Curbs for Chicago's Superhighways

Chicago's $205,000,000 superhighway program may cost about $25,000,000 less if a new mobile curb is used throughout the system. Using the curb will cut down the amount of land needed and the number of buildings which must be condemned for the right of way; and will give a 100-ft.-wide pavement the same traffic capacity as a 160-ft. pavement of conventional design. At the push of a button the curbs will rise from the ground or drop flush with the roadway. The 100-ft. pavement which will be divided into ten lanes, will have the curbs so arranged in the morning rush hour that eight lanes will be provided in the direction of the heavy flow of traffic, two for the light flow. For the evening rush hour the proportion will be reversed. During the rest of the day five lanes will run each way.

The Multi-Stage Process of Cement Grouting

There are numerous instances where the ordinary method of cement grouting as a means of sealing rock strata against the percolation and seepage of water fails to achieve its object. The improved process described here, called the multi-stage process, consists of injecting a cement-water grout to refusal in holes bored in the rock, as in the normal process, and then repeating the operation at intervals. In the example given, two types of holes were drilled, some 25 ft. deep and some 60 ft. deep. The shallow holes are treated first, the lower part being filled with sand while grout is injected into the upper part. After injecting to refusal, a hole is left for a time, at the end of which it will take more grout. After consolidation of the upper layers the sand is blown out and the lower part of the hole treated in the same way. Finally, the same process is applied to the deep borings.—J. M. Antill in The Commonwealth Engineer, reported in Road Abstracts.

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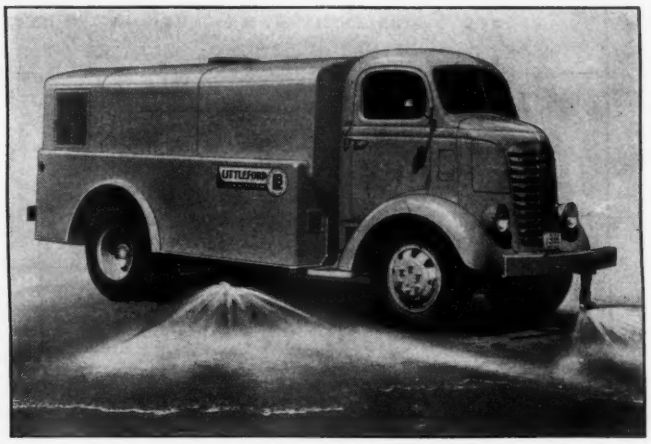
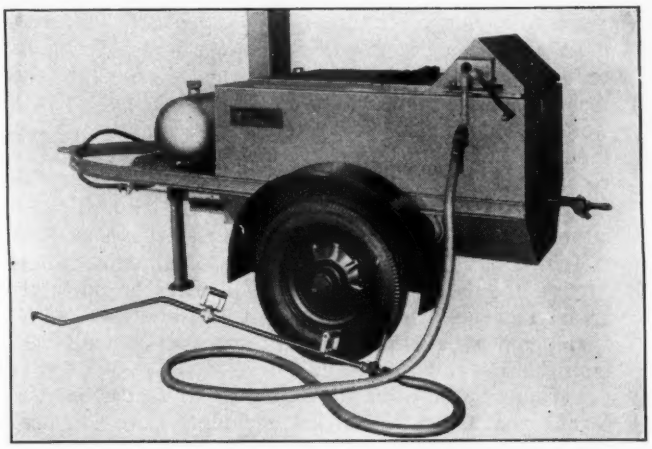
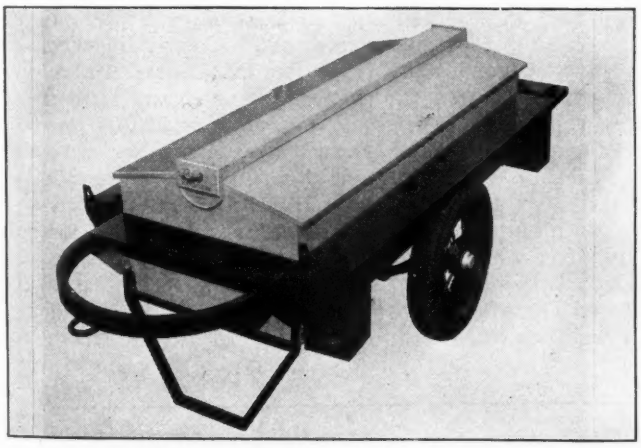


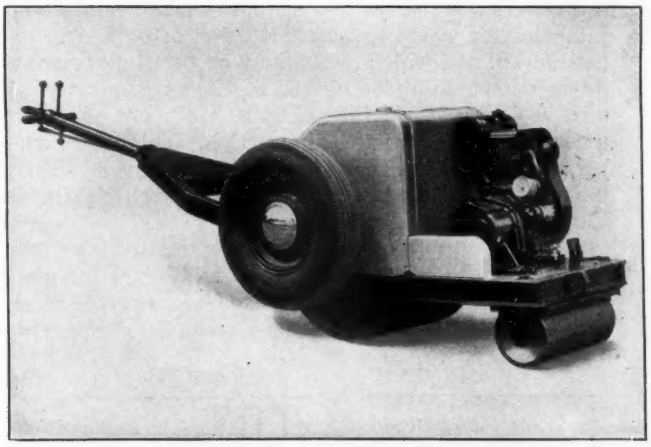
Street Flusher — The Littleford Model A De Luxe Street Flusher is streamlined, modern, three-nozzle machine with self-starter, has vacuum controls to give the most efficient operation.



84-HD Tar Kettle—Here is the fastest heating kettle. Has the patented "Double Heat Circulation" system and the "Screened Reservoir." A continuous flow of materials is available.



Tool Box—This all-steel HanDeeBox is the most efficient and safe way to take expensive tools to the job. Lasts a lifetime; is tamper proof, rust proof and thief proof. Compartments keep tools in proper place.



Model 150 Wheeled Roller—This portable roller can be trailed from one job to another behind any truck. Designed for rolling patches. Gives 150 lbs. of compaction per inch of roller width.

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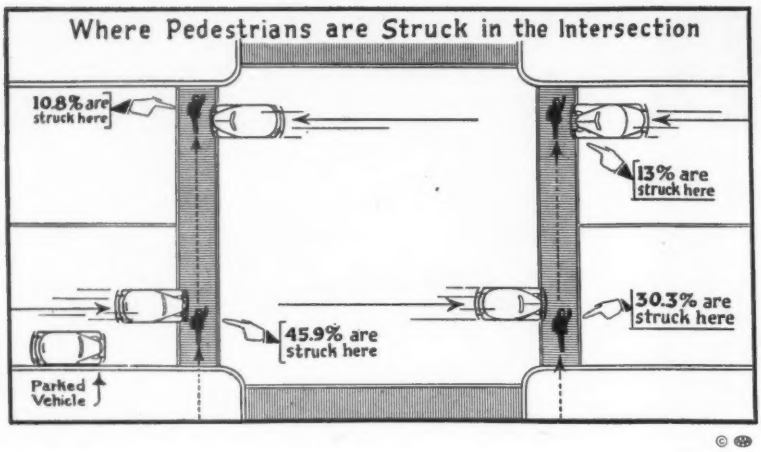

Where Pedestrians are Struck in the Intersection
10.8% are struck here
13% are struck here
30.3% are struck here
45.9% are struck here
Parked Vehicle

What Engineers

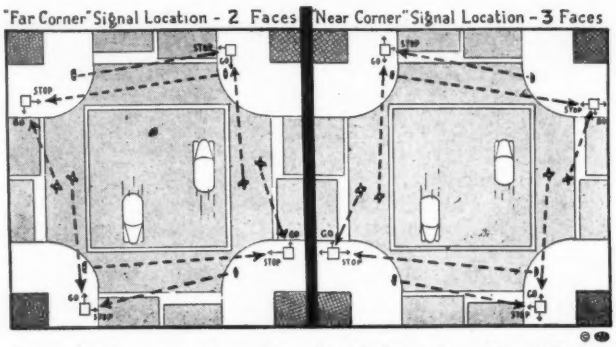
The first few steps off the curb are the most dangerous.

UNLIKE collisions between motor vehicles, which are to a considerable extent concentrated at local trouble points, pedestrian accidents are generally widely scattered. They appear to occur almost anywhere and few of the sites where pedestrians are killed one year are likely to appear in the statistics the next. In Philadelphia, in 1936, 188 pedestrians were killed at 187 separate locations. Only ten of these locations appeared in the pedestrian fatality records the following year.

The less serious pedestrian accidents tend to occur most frequently in congested business districts. The more serious and fatal accidents occur most often outside the business zone in residential or outlying areas. Here vehicles move faster. Drivers and pedestrians tend to be less alert, and there usually are fewer facilities for traffic control.

Perhaps the most significant general fact about the *location* of urban pedestrian accidents is that a majority occur away from intersections in what is termed the "mid-block." Records for 54 large cities totalling 3,468 pedestrian fatalities show that 53 per cent occurred away from intersections. This figure is conservative since it does not include a large number of fatalities for which the exact location of occurrence is not known, and which most likely occurred away from intersections. In Washington, D. C., three out of five occurred away from intersections. Only one in seven occurred at a signalized intersection. While the number of intersections that are signalized may be small, the volumes of pedestrian and motor vehicle traffic using them is usually very great.

Accurate information should be obtained on all pedestrian accidents. Normally this will be the function of the police department. An excellent and complete form has been prepared by the Bureau of Police, Department of Public Safety, Philadelphia, Pa., which may be used as a model.

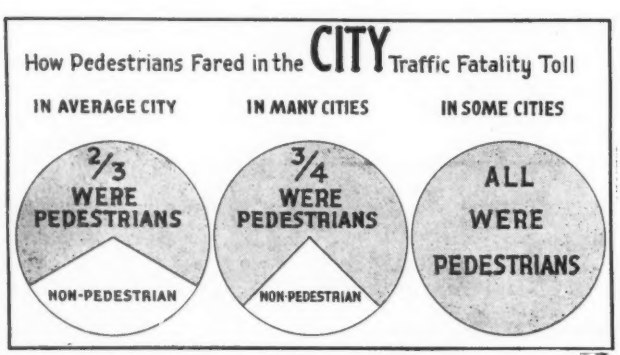


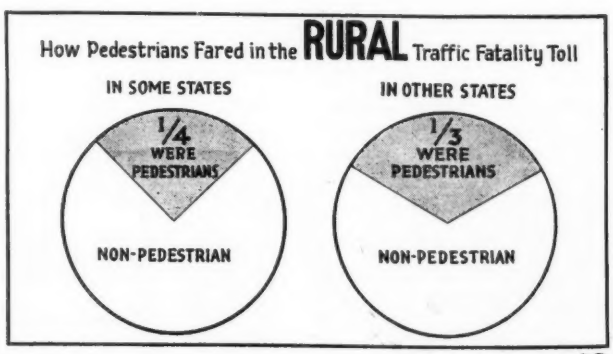
For pedestrian protection, there should always be a signal directly ahead.

Good Crosswalks Needed

Provision and maintenance of clearly marked crosswalks at all intersections is one of the fundamental needs for the improvement of pedestrian conditions. Such walks are desirable psychologically, if pedestrians are to be encouraged to cross only at intersections and not "in the mid-block." Clearly marked crosswalks at intersections also remind drivers of their obligations to pedestrians, while at unusually located crosswalks effective marking is *essential* so that drivers may know *where* they have such obligations.

The most practical means of identifying crosswalk areas clearly are by paint strips or buttons and by proper night lighting. A crosswalk should be at least eight feet wide, and somewhat wider than the usual sidewalk in central business districts where traffic is dense. The effectiveness of cross walks is dependent on qualities which continuously compel attention both





Rural pedestrian toll is large, but not as bad as it is in our cities.

Can Do for Pedestrian Protection

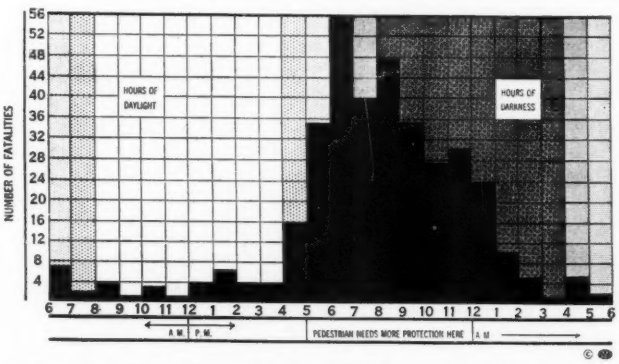
It is astonishing that so little emphasis has been directed to pedestrian safety and to pedestrian phases of the traffic problem. This article, based on an exhaustive study by the American Automobile Association, is intended to emphasize the part that engineers can take in reducing accidents to pedestrians.

day and night. The importance of a good crosswalk maintenance program cannot be overemphasized.

Traffic marking paints vary widely in wearing qualities. In actual road tests some wore off in two or three weeks while others were effective after two to three months. Some manufacturers sacrifice durability unduly to gain attention for the speed with which their paint dries, so that traffic will not "pick up" the paint. All traffic paint should be bought on tested specifications. Good sample specifications are available through your own State Highway Department.

Pedestrian Barriers Are Useful Devices

Barriers of chains, ropes or pipes for protecting pedestrians should be provided by every community at locations where conditions warrant.



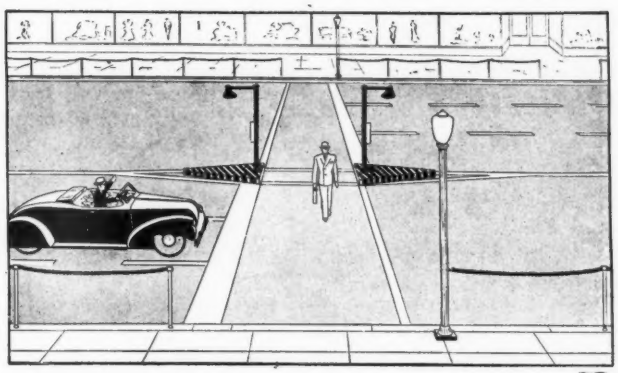
Three-fourths of the pedestrian fatalities occur during one-third of the day.

Another type of pedestrian barrier is coming into use. It is ordinarily used where roadways are divided by medial strips. The barrier itself is created by planting hedges or shrubs in the area made by the medial strip or dividing island.

Hedge barriers which are thick and high enough make it impossible for pedestrians to cross in the midblock. High hedges also provide an effective night screen which cuts down or eliminates glare from oncoming headlights. Such barriers can also add to the appearance of the areas in which they are used.

The Use of Traffic Signals

The "stop-and-go" signal with an automatic, fixed-time controller is the most common device for controlling traffic at intersections. Where properly used, motorists have accepted the traffic signal as a sensible means for establishing order, convenience and safety at intersections. In those cities where pedestrians ignore the traffic signal, the first corrective step is to make such changes as are necessary to fit the signals also to the needs of pedestrians.



Mid-block cross-walks are a help, but who ever saw a car stop for a pedestrian.

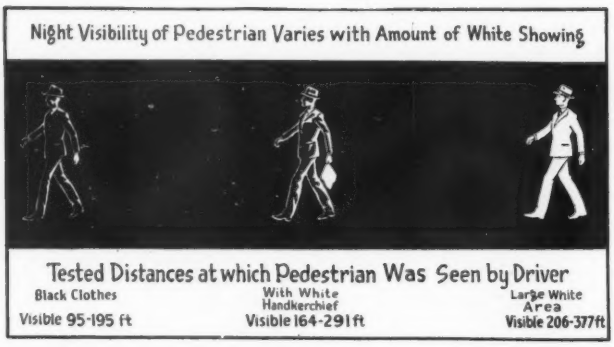
Any signal face that the pedestrian must observe and obey should be placed directly in his natural line of vision. A short cycle is best for both pedestrians and vehicles. Right turns on red lights should not be permitted. Some places provide a "pedestrian signal" or "wait" and "walk" signal, which are advantageous in many ways, but also slow traffic. Pedestrian-actuated signals, with push-buttons are sometimes used where foot traffic is heavy at certain times only, as at schools, factories, etc.

Pedestrian and Loading Islands

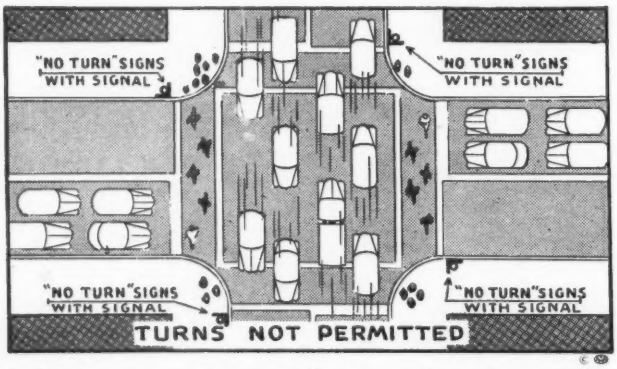
In recent years, pedestrian islands and streetcar-bus loading islands have been widely accepted as highly useful and desirable pedestrian aids. Since 1931, Chicago has built nearly 1,250 such islands. Detroit has erected 100 or more. In 1935, the American Transit Association reported that there were about 3,000 "protected" islands in cities of 100,000 population or more, but this number has greatly increased since. Such structures have a high rating in the list of things that are worth doing for pedestrian convenience and safety.

Loading islands are usually from 50 to 100 feet long, at least four feet wide, and six to eight inches high. Length depends on the length and the maximum number of streetcars to be loaded at one time. All streetcar entrances and exits should be accessible from the island.

Various types of steel and concrete loading islands are in use. Some are made of wood, while sometimes most of the same purposes are served by outlining the zone area, except on the car-track side, with sturdy


Night Visibility of Pedestrian Varies with Amount of White Showing
Tested Distances at which Pedestrian Was Seen by Driver
Black Clothes
Visible 95-195 ft
With White Handkerchief
Visible 164-291 ft
Large White Area
Visible 206-377 ft

Don't wear the conventional black too often!


"NO TURN" SIGNS WITH SIGNAL
"NO TURN" SIGNS WITH SIGNAL
"NO TURN" SIGNS WITH SIGNAL
"NO TURN" SIGNS WITH SIGNAL
TURNS NOT PERMITTED

Prohibiting turns safeguards pedestrians and speeds up traffic.

steel posts. Proper night illumination is of vital importance and should include effective flood-lighting, at least at that end of the platform which vehicular traffic approaches.

Tunnels and Overpasses to Separate Traffic

Pedestrian tunnels and overpasses are facilities which under special conditions have no equally satisfactory substitute. They separate vehicle and pedestrian traffic, and to the extent that they are used, the opportunity for conflict between pedestrian and vehicle traffic is removed.

Justification for their construction and use is most complete when heavy volumes of pedestrian traffic must cross a very heavy vehicular flow. Such conditions are likely to be found near outdoor sports arenas, near schools where children must cross a heavy traffic artery, near factories, and at some other places. Where pedestrian origin or destination points are at a different level than the street, the likelihood of general *use* of a suitable tunnel or overpass is especially great.

Los Angeles is an outstanding example of a city which has constructed numerous pedestrian tunnels near schools. These tunnels have been found very effective for school children, but unfortunately many adults will not use them, partly because of the stair climbing necessary. Ramps help to overcome this objection. Tunnels should be well lighted and kept clean. Frequent police supervision is also recommended, especially where tunnels are to be used at night.

Cities Should Check Lighting Facilities

Minimum standards for street lighting have been established by the Illuminating Engineering Society. Relatively few streets measure up to these standards, although the study cited above indicates that lighting in excess of standard is desirable for accident prevention. A first step in approaching the problem of night accidents, therefore, is for city authorities to check city street lighting with the I. E. S. Code. If the city does not employ a trained illuminating engineer, a consulting professional might be employed, or a study might be made by the city engineer in cooperation with the local utility company.

Traffic Engineering Service Needed

Practical application of the bulk of the suggestions made in this article is logically the responsibility of a trained traffic engineer. Every state and every city of 50,000 or more should employ such an engineer on full time. Traffic conditions today in most cities have reached a point where trained professionals are necessary if quick and efficient solutions of traffic problems are desired. In the long run, this is the cheapest and most practical method of improving conditions.

For cities of smaller size, traffic engineering service is just as necessary as in larger cities. Probably the most practical method of securing such essential service is through part-time assistance of regional traffic engineers employed by the state. In metropolitan counties, a county staff may be preferable. Until such state or county service can be made available, small communities should retain part-time services of a consulting engineer specializing in traffic and highway work.

In the meantime, the city engineer can and should survey the need for sidewalks in suburban areas, and the county engineer the need in rural areas. Crosswalks should be plainly and clearly marked, and lighting should be studied. These steps will help in reducing pedestrian hazard.

Garbage, Rubbish and Sludge Incineration and Reduction Bibliography

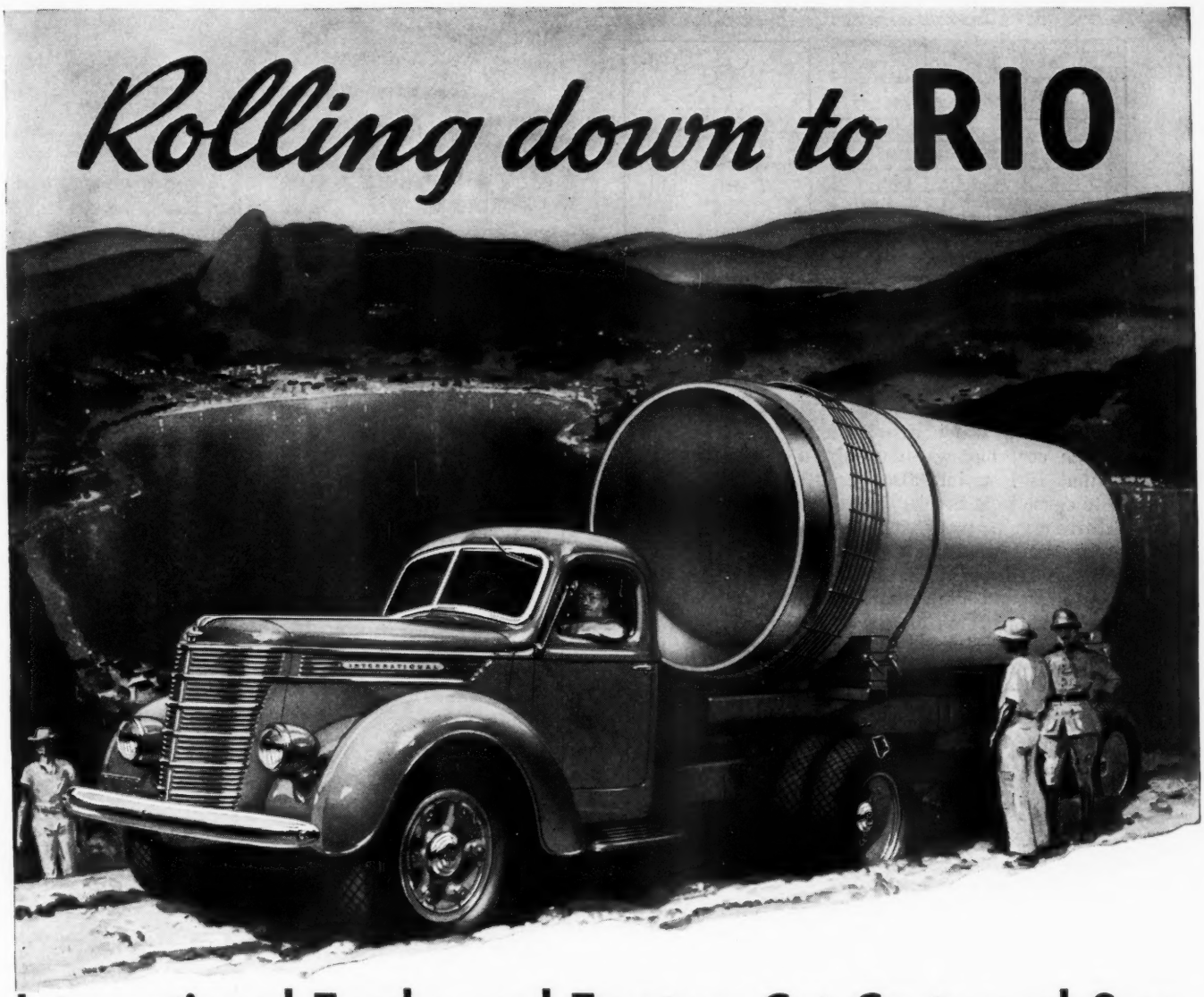
This is another of those excellent and complete bibliographies prepared by the WPA, sponsored by the New York City Department of Sanitation and directed by Prof. Lewis V. Carpenter, Professor of Sanitary Engineering, New York University, University Heights, New York, N. Y. It contains 146 mimeographed pages and is well bound with a durable heavy paper cover. The objectives of the preparation of this bibliography were to select data on carbonization, reduction, fills, hog feeding and other methods to afford an unbiased comparison and evaluation of these processes as compared to incineration; and also to provide a complete index to all the material on these subjects.

Those interested in this important subject of disposal of solid wastes will find this bibliography invaluable. Of especial value are the abstracts under each important article of the material in that article, permitting the reader to determine the essence of the data and whether the complete article will be worth obtaining. We believe this bibliography will be sent free of charge while copies last on request to Professor Carpenter, at the above address.

Setting Permanent Survey Monuments

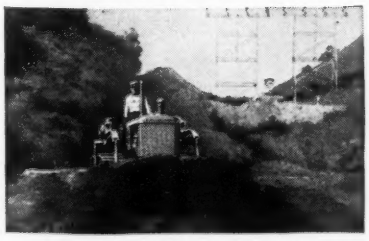
In Miami, Florida, engineers have been setting permanent monuments consisting of a concrete block cast in place with a brass pipe embedded in the concrete to mark the center point. A cast iron frame with a lid is placed on top. Monuments are set five feet north of the centerlines of east and west streets and five feet west of the centerlines of north and south streets. A five-foot offset was chosen because manholes generally occupy the centerline intersection of the streets.

Rolling down to RIO



International Trucks and Tractors Cut Costs and Save Time on Gigantic Water Conductor Project

All set to go! A new load every few minutes.



International TracTracTors clear and grade the right-of-way.

Brazil moves ahead on its march of progress, with a 60-mile aqueduct under construction to bring water to beautiful Rio de Janeiro. Thirteen thousand 22,000-lb. iron and concrete tubes will carry the water. The great project demanded the best in engineering skill and equipment.

International Trucks and Diesel TracTracTors "rolled down to Rio" and went to work for Dahne, Conceição & Cia. (Adductora Ribeirão Das Lages S. A.), clearing, grading, and preparing the right-of-way; transporting tubes, materials, and supplies; and easing the heavy tubes into the trench.

Thanks to the ability of 18 International Trucks and 9 International Diesel TracTracTors, a great city's dream becomes reality!

The world is dotted with such International records. If *you* have a truck or tractor job to do, there's a powerful International that's built and styled for *your* work. Ask the nearest International Dealer or Company-owned Branch for a demonstration.

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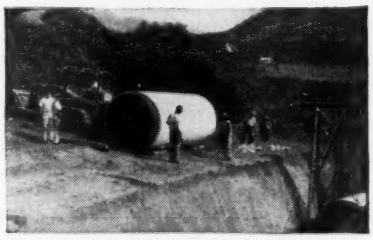
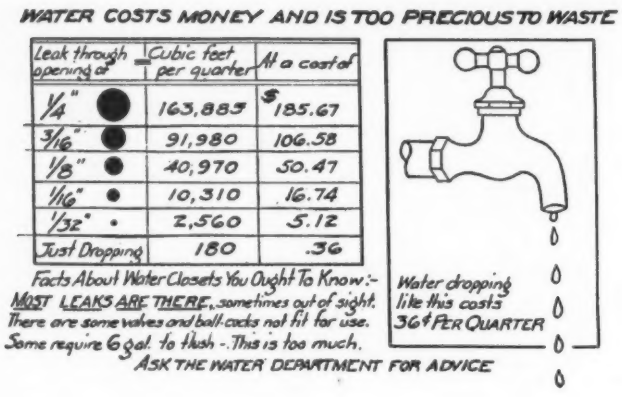


Easing 22,000-pound tubes into place. No cracks, no damage!

INTERNATIONAL TRUCKS


WATER COSTS MONEY AND IS TOO PRECIOUS TO WASTE
Leak through opening of
Cubic feet per quarter
At a cost of
1/4" 163,883 $185.67
3/16" 91,980 106.58
1/8" 40,970 50.47
1/16" 10,310 16.74
1/32" 2,560 5.12
Just Dropping 180 .36
Facts About Water Closets You Ought To Know:-
MOST LEAKS ARE THERE, sometimes out of sight.
There are some valves and ball-cocks not fit for use.
Some require 6 gal. to flush - This is too much.
ASK THE WATER DEPARTMENT FOR ADVICE
Water dropping like this costs 36¢ PER QUARTER

How to Discover Le

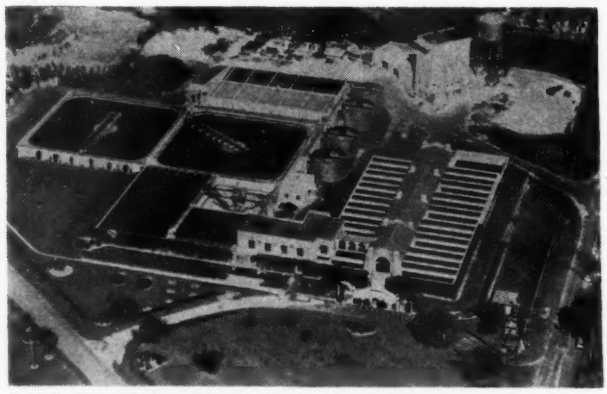
LEAKS in a water distribution or water supply line cost money—not only through the water that is lost, but also because such leaks tend often to cause pipe breaks or failures; and further expenditures may be required for new line or new sources of supply that would not be needed if leakage and waste were reduced to normal amounts. It is good business and good management for any water department to pay the same attention to the searching out and prevention of leakage and waste that it pays to the billing and collecting of accounts.

"Every underground leak in a distribution system," says the latest annual report of the Hartford, Conn., Water Bureau, Caleb M. Saville, Chief Engineer, "sets the stage for a pipe failure, and the longer such leaks run without detection, the greater the likelihood of a serious break. Thus, pitometer work, through the detection of underground leaks, acts to reduce the number and cost of pipe failures." Such failures may be caused in various ways. Probably the most important single cause of failure is the result of the washing away of supporting earth by the escaping water, permitting the pipe to settle. The pipe may break or the joint pull apart. Small leaks are not likely to cause this damage; but small leaks grow into larger leaks and large leaks are highly important factors in pipe failure. Damages from leaks may bring suits (Burgess Journal AWWA, July, 1939). Thus locating leaks in their early stages is important. It is important that leak detection should have a planned and permanent place in any water department program.

In addition to a decrease in pipe failures due to locating and repairing leaks when they are small, and the accompanying reduction in the amount of water lost, prevention of water waste often permits additions to treatment plants and supply sources to be deferred. In regard to this, the Hartford report mentioned above says:

"If all the leakage that has been stopped through our waste surveys had gone on undetected, the 1938 water consumption would have been about 25 million gallons per day, which is 19% in excess of the safe yield of Nepaug Reservoir and 20% greater than the present filtering capacity. From this it would appear that the capacity life of both these structures . . . has been extended by pitometer work and the necessity for extensions has been temporarily deferred."

The same is true of smaller communities. Nine years ago the village of Liberty, N. Y., which supplies three neighboring communities with water, found that its supply line was bringing in scarcely enough water for its own needs. Faced with the apparent necessity of having to duplicate its 8-inch supply line, which is about eight miles long, the superintendent, Charles M. Heidt, Jr., had the line surveyed and carefully checked for leakage. The discovery and repair of leaks totalling more than 220,000 gallons per day and the installation of air relief valves, added to the discovered leaks in the distribution system, almost doubled the available supply of water. Enough additional water was sold to the neighboring communities in the first year thereafter to pay for all the work that was done.



Aerial view of the Miami, Fla., water plant—the center of hundreds of miles of water mains

Clinton, Ill., found and repaired leaks that were causing a loss of 270,000 gallons per day, resulting in an annual saving of $7,000. Youngsville, N. Y., with a population of less than 400, found and repaired leaks in its supply line and reservoir, with the result that the additional supply that appeared necessary eight years ago is not yet required and will not be for some years.

Any community, large or small, will find it good business to search out and repair the leaks in its supply lines and distribution system. Even if the supply does not have to be treated or pumped, such work is highly worth while. And where water must be treated with chemicals, or pumped, the saving in chemicals or power through the curtailment of waste may be very considerable.

Wherever possible, such leakage surveys should be conducted by competent and experienced engineers, or by companies specializing in this work. Better results will be obtained, as the work can be planned on the basis of past experience to produce maximum results quickly, and adequate equipment can be made available for determining the amount of leakage and for locating the actual leaks. Unfortunately many communities believe that the cost of such a survey is too great and fail to look beyond this immediate expenditure to the saving and benefits that will accrue over a long period.

Leaks and Locate Water Wastage

Factors in determining the amount of wastage in supply lines and distribution systems, and methods and equipment for locating sources of losses

Each community can, however, do a great deal to help itself. The equipment necessary for the work is not costly; it can be operated, with little training, by local employees regularly occupied in other water department work. Even though an anti-leak campaign carried on by local forces may not be as effective as one initiated and prosecuted by professionals, it will still pay big dividends on the money spent.

Preliminary Factors

In any and every water works, each water user should be metered. While it is wisest that everyone pay according to the amount of water used, even consumers who are on a flat rate should be metered. When all services are metered and water is paid for according to the amount used, the waste of water through plumbing fixtures that are out of order is reduced, and the income of the water department is kept in proper relation to the amount of water furnished. In addition, metering furnishes the best possible—in fact, almost the only—check on the amount of water that is being lost through leakage in the mains or in the distribution system.

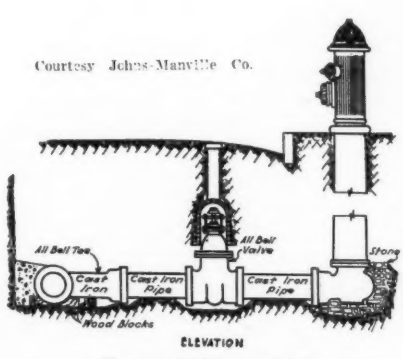
While all such figures are controversial and subject to local conditions, we will assure that 5% of the daily flow of water may be lost because of leaks in the joints or the mains; that about 9% will be lost through service leaks; and that other losses will amount to about 5%. Thus even in an efficiently run system, the unavoidable losses will be about 19%, and not more than 81% of the water will be sold. As a matter of record, in some cities where leakage surveys are carried on continuously and meters are tested at frequent intervals, as much as 90% of the water is sold. This, however, is not normally possible especially in small communities where each house is separate and where the population per mile of main is small, due to the unavoidable leakage in the pipes of the distribution system.

Loss of Water in Pipes.—When a new pipe is laid, good practice in construction (See PUBLIC WORKS, June, 1939) and proper jointing should keep leakage to much less than 100 gallons per day per mile of pipe for each inch of diameter. In fact, it is perfectly possible to keep to perhaps one-tenth of this. Assuming a maximum of 100 gallons per inch-mile, this amounts to about 600 gallons per day for each mile of 6-inch pipe. As pipe remains in service, leakage tends to increase. In an older distribution system, the minimum average leakage that may be expected is about 1,500 gallons per mile of pipe per day. Assuming 300 people per mile of pipe in residential areas, and 600 people per mile in more built-up sections, the loss per person from "unavoidable" leakage will be 2½ to 5 gallons per day; and even double this amount will not be unusual in systems that have been poorly laid or where soil conditions are bad. Older pipes were often laid with a minimum of inspection.

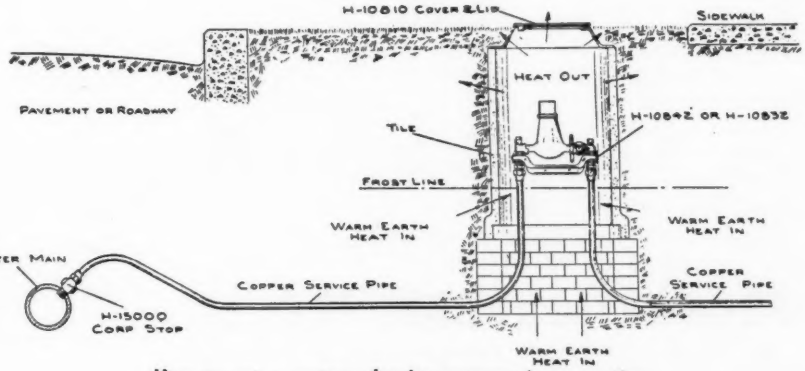
Records of Water Use

Regarding leakage, Thos. F. Wolfe, research engineer of the Cast Iron Pipe Research Ass'n., says: ". . . Tests that we have made in a number of cities indicate that the loss by leakage is nearer 2%. The tests we made, of course, do not include any loss due to large breaks," but since these would be discovered quickly, the loss of water would be small.

The Cast Iron Pipe Research Association further says: "We have recently conducted a leakage test survey of cast iron mains in 25 cities in various states. The mains tested range from several hundred feet to more than twenty miles in length, in sizes from 4" to 30" and up to 44 years old, either with no service connections or relatively few that were turned off during the tests. The average leakage per mile of pipe, per inch of diameter, per 24 hours was 41 gallons—or an average of 380 gallons per mile of pipe per day for the sizes tested."

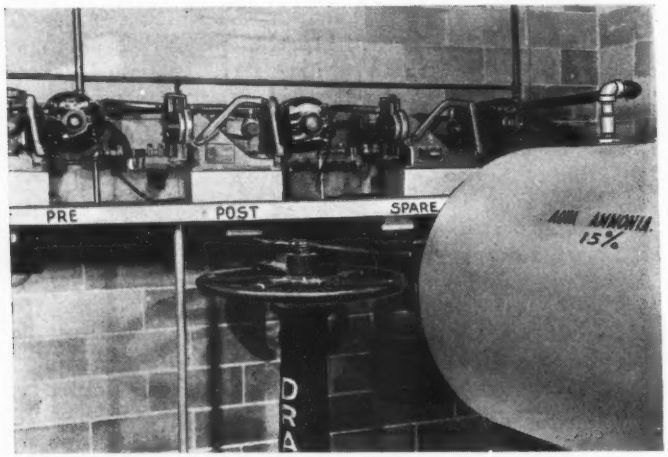


Correct hydrant setting



How to set a meter, showing gooseneck connection

"We are saving $105 per month by feeding Aqua Ammonia with Amm-O-Feeder, instead of using Anhydrous"—thus writes a chemical engineer who has proof of his figures in actual records from a plant (illustrated here) formerly using anyhydrous ammonia. In another plant, just starting this feeding method, he expects to save $250 per month! **You should investigate**—the chemical costs less, the feeder



costs less—there is no limit to the size of the plant which can save by using aqua—in fact, the larger the plant the larger the savings.

XSD CHLORINATION

(i.e., excess and de-chlorination) brings the story-of-the-month in the form of a letter from **Ottumwa Water Works,** Iowa. Faced with severe drought and low river conditions, with a surplus of sewage the community faced a health problem which was dangerous. They tried super-chlorination, then de-chlorination using a % Proportioneers % Midget feeding sodium-bisulphite, and the problem was licked!

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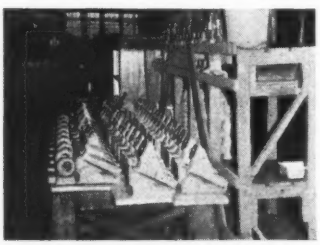

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In any water system there are certain procedures which should be followed and which will ordinarily result in knowing (1) how much water is supplied to the community per day; (2) how much is sold to the public or used for public purposes; and (3) how much is lost. With this important basic information available, it is possible to determine the need for a leaking survey; also, these data will help in determining such other important factors as future needs and policies in regard to necessary reinforcement of or additions to the distribution system or parts of it.

Main Line Meters.—On the main supply line there should be one or more meters. These preferably should be of the type that record the total flow and also indicate and record the rate of flow through the meter. Venturi meters are ordinarily used for this purpose, with charts on which are recorded the rate of flow at all times. If desired, these charts can be installed in the office of the superintendent and operated by remote control, through a telephone or other wire.

Such a meter should be placed at the intake, on a gravity line, or at the pump outlet if the water is pumped. If the line from the intake or pumps to the distribution system is long, another meter should be placed where the supply line feeds into the distribution line. Any difference in the readings of these meters will show the amount of leakage in the supply line. Also when meters are placed on both ends of the supply line, they can be used to indicate the condition of the interior of the pipe line as it relates to discharge efficiency, thus determining the need for cleaning or other repairs. The head or fall of the pipe being known, it is easy to compute the flow coefficient of the pipe. Also, such a meter permits determining the efficiency of the pumping units, where pumps are used.

There are several manufacturers of Venturi meters who will recommend types and sizes and install controls as required by local conditions.

Pumping Records.—The recording meter at the pumping plant will always show the amount of water delivered by the pumps. If a record is kept showing the number of hours that the pumps are operated, the meter furnishes a ready check on the way the pumps are performing. There are many pumps in operation that it would be economical to replace because they are using excessive power for the work they do. In some cases this has been caused by changes in conditions after the pumps were installed. For instance, a centrifugal pump operates efficiently at a certain designed head, speed and volume. If new construction has increased or decreased the head under which the pump operates, or the speed of operation has been increased or reduced, the pump efficiency is likely to be considerably reduced. Also, there are many old pumps in service that do not perform efficiently enough to justify their continued use, even though they are not entirely worn out.

Relation Between Day and Night Flows.—Where a gravity line feeds directly into the distribution system, a recording meter of the type mentioned is valuable in leakage and waste studies because it will show the relation between day and night flows. Normally use of water after midnight is very small; therefore, in a system where leakage is kept at a minimum, the night flow will be much less than the day flow and if the meter shows that this is not the case, leakage and waste are indicated. As a general rule, the minimum night rate should not exceed 50% of the daily consumption.

Meter Readings.—If every service to which water is supplied is metered, whether or not that service is

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free or paid for or on a flat rate, the sum of the meter readings will provide an excellent check on the water that is lost. In most communities, service meters are read at intervals of one to three months, and then usually by a rotated system, since it is not possible to read every meter on the same day. It is therefore impossible to have an exact check on consumption as compared to the water actually delivered for any specific day, but by taking periods covering 3, 6 or 12 months, the check will be sufficiently close for all practical purposes and will show the amount of water that is actually delivered to the consumers. A comparison of this amount with the amount registered through the supply line, due allowance being made for public uses of the water, will show the percentage of lost or unaccounted-for water.

Hydrant Pressures.—Pressure readings taken on hydrants also afford a valuable check on distribution facilities and adequacy. Readings taken during periods of high consumption—between 8 or 9 in the morning and 4 or 5 in the afternoon—may be compared with similar pressure readings taken between midnight and very early morning. If the daytime pressures are materially lower, distribution piping facilities in that section may be inadequate or leakage may be robbing the users. Also, if the hydrant elevations and the static pressure in the main are known, it is easy to compute the pressures that should result. Pressures materially lower than computed pressures at night when consumption should be low, indicate leakage.

Hydrant pressure tests should be made, as a matter of good operation policy, three or four times a year and the results recorded in a card and filed. These

tests show the adequacy for fire service of each hydrant; and over a period of several years may give good indications of needs for additions and changes in the distribution system. Pressure tests may be combined with the customary hydrant inspection and testing, but both day and night pressures should be recorded.

Distribution System Plans and Records.—It is an essential in any well-operated water department to have a complete record of the entire distribution system, with detail drawings showing the locations and sizes of all pipes, valves and hydrants. Elevations of each hydrant are desirable and permit the computing of probable pressures which can be checked against actual pressures as already mentioned. The exact location, with detailed references to help in finding, should be available for every valve, and for reasons appearing throughout the article there should be enough valves. Desirable information on pipe lines includes, in addition to size and location, the date laid, kind of pipe and kind of joint used, as well as any record on leakage tests at the time of construction; on valves, the record should include date placed, size, make, opening right or left, and proper referencing to enable quick location of the valve, even with snow on the ground; on hydrants, data should include the date placed, capacity, size, kind, static pressure, make and location.

Necessity for Such Records.—Records of the kind that has been listed, including flow through the supply line, amount of water sold and day and night usage, are necessary if any adequate leakage survey is to be made; and they are also invaluable in the daily operation and maintenance of the water department. A brief description of the record system used in Bradford, Pa. (PUBLIC WORKS, Feb., 1940), illustrates the methods employed in one well-operated system.

It is not possible to make an adequate leakage survey if no records are available for water supplied or water used. In that case, the work of carrying out the waste survey will have to include the gathering of the preliminary information that has been outlined.

Some Sources of Leaks and Losses

Unaccounted for water was classified by A. P. Kuranz, superintendent of the Waukesha, Wisc., Water Department, in a recent paper before the Illinois Water Plant Operators' Ass'n, as follows:

1. Leaks in mains and services,
2. Slippage and underregistration of meters, and
3. Water used in public buildings and schools, and for street and sewer flushing.

In this article, principal attention is given to leaks and losses in mains and services, that is, in the distribution system proper, and to methods of locating them. The slippage and underregistration of meters is a problem in itself; and the matter of usage of water in public buildings and for public purposes is one for local decision, though some arrangement should always be made so that the amount used is known or can be estimated closely.

The order of importance of leaks, according to C. E. Corrington of Clinton, Ill., who spoke on the same program with Mr. Kuranz, is as follows:

1. Abandoned services,
2. Broken goose-neck connections,
3. Leaks in old galvanized piping, either small mains or services,
4. Defective valves, and
5. Actual leaks in mains and joints.

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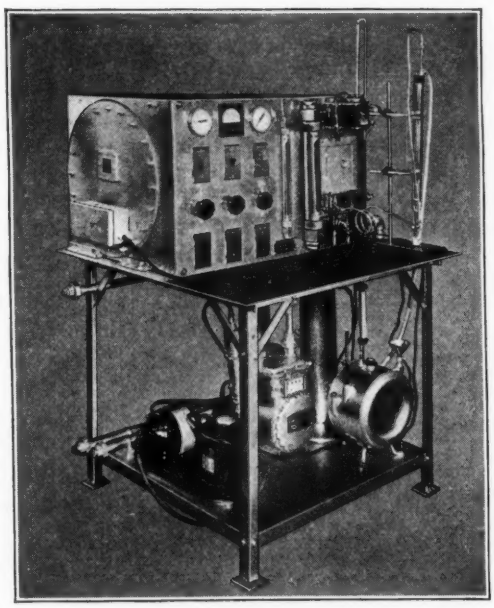

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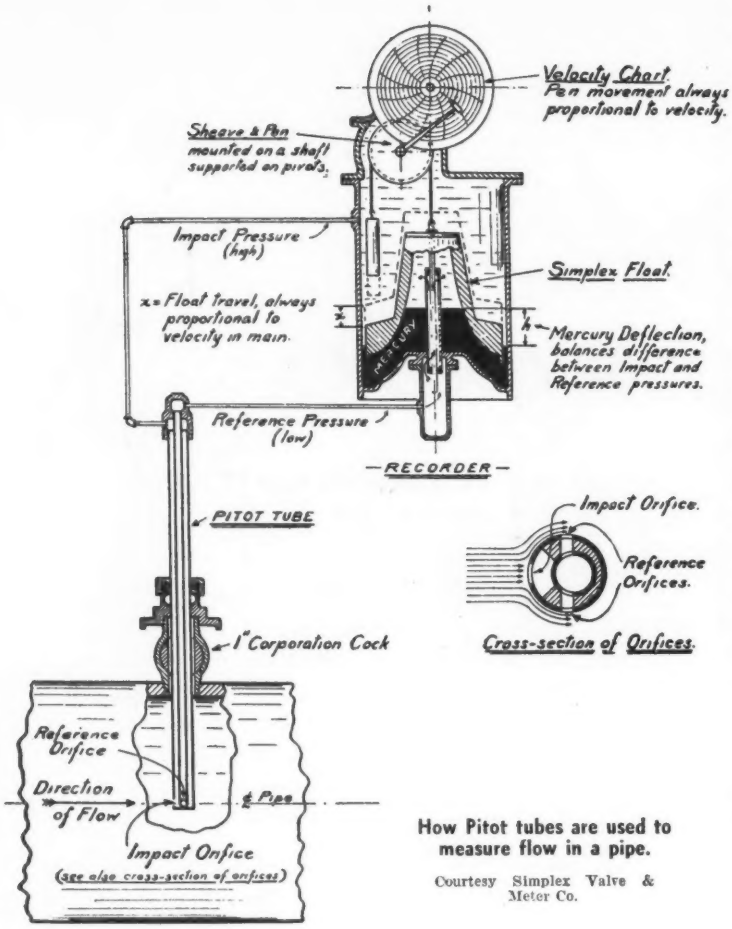


How Pitot tubes are used to measure flow in a pipe.

Courtesy Simplex Valve & Meter Co.

Local conditions may modify this order considerably. Where special attention is paid to checking and recording all services, and where meters are placed at the curb, loss through service lines may not be the most important. For instance, a high pressure in the distribution system, coupled with careless joint construction or the use of poor practices in laying of pipe, may result in undue losses from this source. The alert superintendent should be able to judge closely where the most of his losses are and can prepare his own list, similar to that given by Mr. Corrington, but properly weighted for local conditions.

Losses Through Service Pipes.—It is surprising that in almost every community there are a number of unrecorded services. Taps are made by unauthorized persons; records of properly made and authorized connections are lost, or the connections are not reported through carelessness or accident; or any one of many other contingencies can occur. A well-organized system of records and free use of a good pipe locating device will prevent much of this, but rarely all. Loss of water through such services may be both important and difficult to locate. Careful records, plus field inspection and leakage tests and investigations are necessary.

Abandoned services are also important. Many cases have been reported where such services have flowed unchecked for years. Local springs are not infrequently due to this cause, or to leaks in distribution piping.

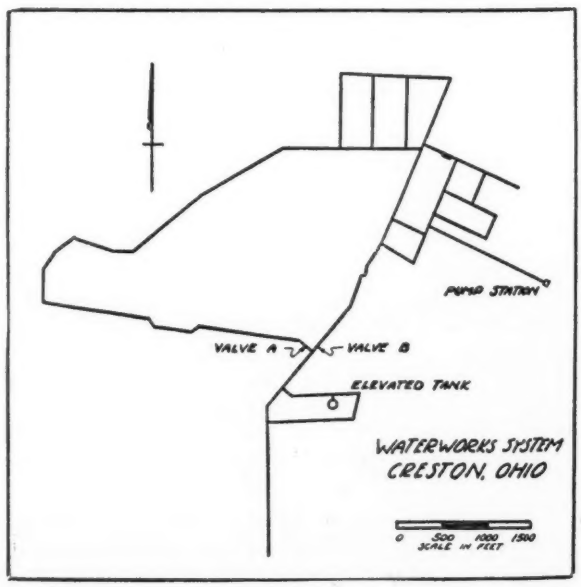
Due to enlargement or change of use of a building, the existing connection may be inadequate and a larger one may be installed, the original one being cut off at the building line; or if two or more taps were made originally for a building and the water use decreases, one or more may be similarly cut off. These unused connections may break between the main and the building line; or may be broken by street or other construction work; or the building originally served may be burned or wrecked. Meanwhile, the service may continue to flow for months or years.

In some cities, before a street is paved, a service line is laid for each vacant lot to or beyond the curb or sidewalk line in order to avoid having to cut into the pavement later. Such unused connections may fail or leak due to age or may be broken or damaged in construction work, thereby causing a serious leak.

Goosenecks. — Goosenecks are ordinarily installed in such a manner that a little slack is available to permit movement between the main and the service pipe. Any unusual movement of either may place an undue strain on the connection and cause a leak. Such a strain may be caused by incorrect measurement or cutting of the house service pipe and an attempt to compensate for this by pulling the gooseneck straight; by careless laying of the service pipe; by street excavations which by moving the service pipe injure the connection; by street or sewer construction which permits the water main to settle unduly; or by a number of other causes. The gooseneck being ahead of the meter, any leakage through it is not recorded by the house meter.

Service Pipe Leaks.—When the meter is placed in the cellar or basement, leaks in service pipes represent unaccounted-for water. Such leaks may be due to poor construction or to the use of unsuitable pipe for services, or both. Corrosive soils may destroy quickly some types of service piping. The water department should regulate and carefully inspect the laying of services, as ordinances without inspection will always be ineffective.

Main and Joint Leaks.—Some leakage is certain to occur in all mains. This can be kept to a satisfactory minimum by care in laying pipe, making joints and testing before the line is covered. Good practices in the construction of pipe lines and joints were described in an article, of the same nature as this one, which appeared in the June, 1939, issue of PUBLIC WORKS.



This shows a typical layout for a small town distribution system. Where should additional valves be placed to control flow to every part of the system?

Special attention should be given to the selection of the material for small pipe lines. The larger pipe normally used in most distribution systems is not affected by ordinary unfavorable soil conditions, such as corrosivity; neither is the 2-inch cast iron often used for small-size extensions to serve thinly settled areas. Such 2-inch pipe is made with factory threaded joints and is fitted with tapping collars.

Finding and Repairing Leaks

The importance and extent of the losses that may occur through undetected leaks, the general means of checking for such losses and the usual more important sources of leakage have been outlined. A summary of the common methods for finding leaks and descriptions of some of the equipment most useful in doing the work will be given.

Checking Water Use.—The first step in any program to reduce water loss is to determine the amount of water supplied and the amount that is delivered. The amount that is delivered can be determined by checking the amount sold through meters and adding to this the actual—or if this is not known, the estimated—amount used in schools and public buildings, for street and sewer flushing and for all other purposes.

The difference between the amount supplied and the amount used will represent more or less accurately, in accordance with the completeness of the records and the care employed in preparing the figures of water use, the amount of water that is unaccounted for, or has been lost.

If the work is to be done by men employed by the water department, the procedure outlined hereafter may be followed with such modifications as appear desirable because of local conditions.

Supply Line Leaks.—If the supply line from the source is metered, as already discussed, at both ends, the leakage in the line, being the difference in the readings of the two meters, less the amount taken off by taps or connections between the meters, is known. If the line is not metered, a pitometer is used, and taps are made into the line near the source of supply and near the connection to the distribution system. The flow is measured at these points. Care must be taken that the conditions of water use are the same when the two readings are taken.

In case no records at all are available, enough readings should be taken to determine the expected flow. For instance, if tests are run at the intake end of the line between 8 and 12 each morning for enough mornings to determine the actual use, a basis will have been established for the readings at the other end of the line. If the records show that Monday flows are high and variable, comparisons should not be made at that time; instead a day and an hour should be determined when rates of use are fairly uniform.

Courtesy Water Leak Detector Co.

A pipe locater saves a lot of time

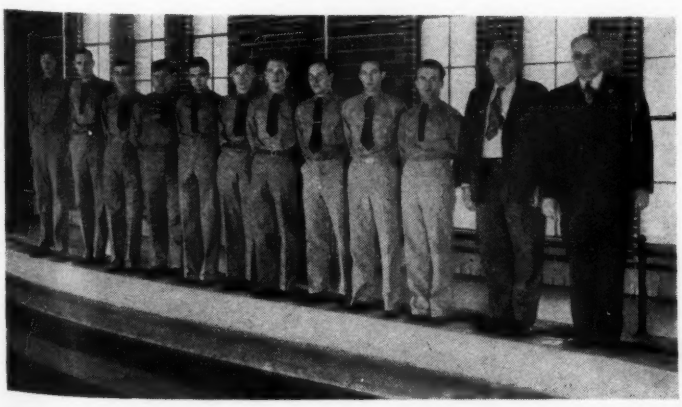
If there is an appreciable difference between the flows as recorded at the two ends of the line, leakage is indicated, and other readings should be taken at various points along the line until the leak or leaks are located, attention being given to the variable rates of flow that may occur from day to day and hour to hour.

Visual examination of the line will sometimes locate leaks; wet areas near the line and places where grass grows unusually abundantly are indications of leaks. However, except in dry weather this method is very unreliable, and in porous soils is of no value. Testing by instruments under conditions selectetd so as to be truly representative must ordinarily be used for successful results.

Comparing Day and Night Flows.—Where the supply line feeds by gravity into the distribution system, a comparison of day and night flows will give valuable information on the probable leakage. Day and night flows in the distribution system should also be studied. The proper ratio between day and night flows depends so much on local conditions that no statement will hold for all conditions. The local superintendent should be able to judge what his own conditions are. In a residential community, flow between midnight and daylight should be much less than the average flow—probably not more than one-half the average and one-fourth of the day-time use. In a manufacturing community using an appreciable amount of water for industrial purposes where night work is not carried on, the night use should be a much smaller proportion of the day use, the amount depending upon the water use by industry.

Testing for Leakage in Distribution Systems.—Standard practice in testing for leakage in distribu-

University of Iowa, Iowa City, March 1940. Showing staff of students operating the University's 1,500,000 gallon Water Works. Left to right: Paulus, Pfeiffer, Davis, Aschenbrenner, Oliver, Trygg, Meyer, Kellogg, Meintzer, Jacobson, chief operator; Mr. A. A. Smith, Supt. of grounds and buildings, Professor Jack J. Hinman, Jr.



tion systems is to divide the city or village into sections for testing. In planning and laying out this work, a map of the distribution system layout is necessary. Valves must be so located that sections of suitable size for testing can be isolated and the flow into them measured.

The section to be tested is so selected that all but one pipe leading into it can be closed off. The flow through this pipe is then measured. If the night flow is large as compared to the day flow, leakage is indicated, and the search should be continued by further subdividing the district and testing these subdivisions. If necessary, the work is carried down to the testing of individual streets.

When the water is flowing into such a testing district through a single pipe, there must be some means for measuring that flow. In few, if any, cases will a properly located meter be available. The main may be uncovered and tapped and a pitometer installed to determine the amount of flow. If the pipe is located under a hard surface pavement that carries considerable traffic, it is undesirable to cut into it and another method is preferable. A connection may be made between two hydrants—one outside the district to be tested and the other inside of it. The easiest connection is by means of sections of fire hose in which a meter of suitable size for the district being tested has been installed. After the connection has been made, both hydrants are opened and then all pipes leading into the district or area under test are closed off, care being taken to close the valves completely.

The water that is being used or is being lost through leakage in the section under test must pass through the hose and meter into the hydrant. Thus the flow into the test section is shown and can be recorded. A thorough knowledge of the character of the section under test and a study of the probable night use of water will indicate whether leakage is a serious problem.

Each section that shows or indicates a considerable leakage is further subdivided into smaller areas and the tests continued, even down to single blocks. When the work has reached this point, a house-to-house examination may be made to determine possible leakage in house services or in the street mains. This final step is usually carried out by the use of one of the several types of leak detectors.

Reservoir Leakage—If water is stored in or passes through distribution reservoirs, these should be checked for leaks. It is not unusual to find that important leaks or losses occur in reservoirs. As a matter of fact, any leakage survey should be broad enough to locate and determine the cause of any unusual flow and to trace all important amounts of water from the source of supply to the ultimate consumer.

Leakage Practice in Reading, Pa.—A continuous leakage survey carried on in Reading, Pa., was described by A. R. O'Reilly before the Pennsylvania Water Works Operators' Ass'n. This survey, which was established about 1927, covered all distribution mains and supply lines. Two leak patrolmen inspect the 160 miles of pipe every three weeks. Thus major leaks cannot go undetected for longer than three weeks. As a result of this work, a regular feature of the department, unaccounted for water was reduced in the first six years that the survey was in operation

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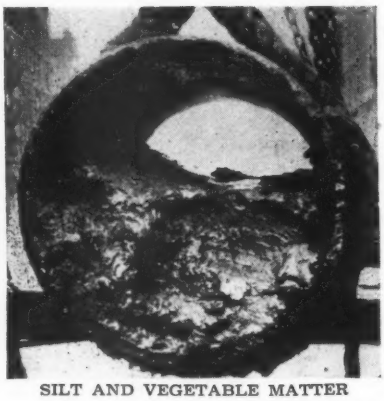

SILT AND VEGETABLE MATTER

More than any words, these pictures tell the startling story of impaired mains capacity and increased pumping and distribution costs due to scale, corrosion, sedimentation, or vegetation in water mains.

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Too late now for preventives! It's time for *cleaning*—proper mechanical (NATIONAL) cleaning, in connection with installation of treatment facilities to keep your mains clean thereafter.

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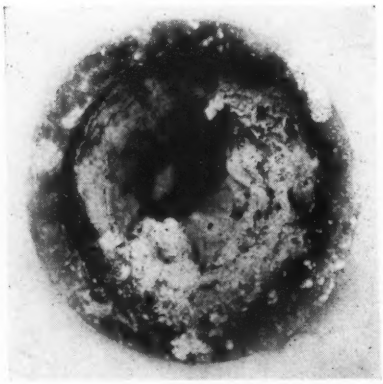
We guarantee to restore 95% of original capacity of mains; at a surprisingly low cost, which operating savings ultimately repay.



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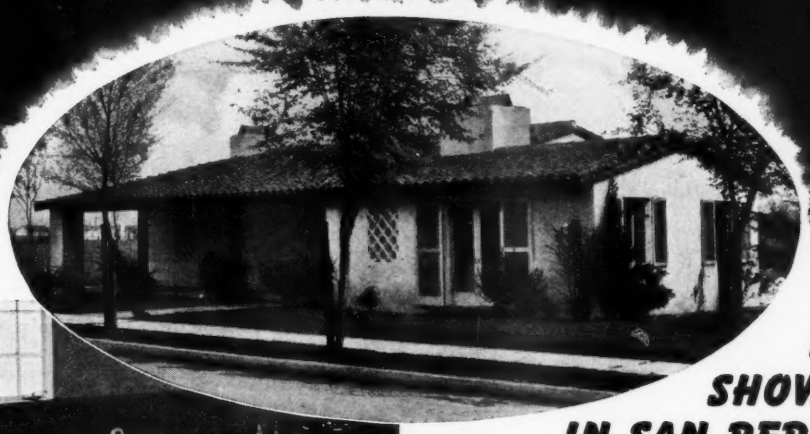
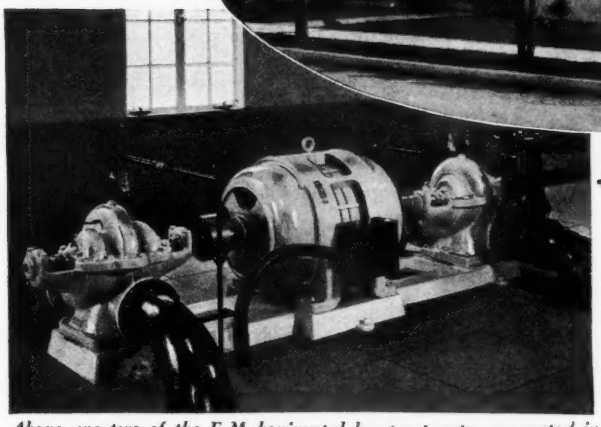


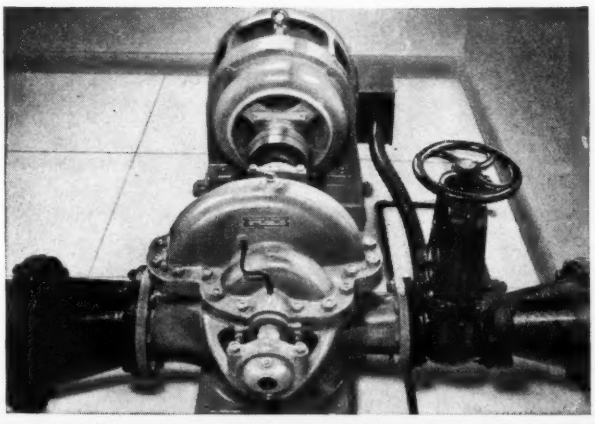


Above are two of the F-M horizontal booster pumps, connected in series and powered by a 100-h.p. F-M Motor in the Antil station. When tested for acceptance, this unit far exceeded its guaranteed efficiency. Operating at a head of 200 feet, it discharged 1503 g.p.m.

IS A SHOW PLACE IN SAN BERNARDINO

INSTEAD of one central pumping plant, the water department of San Bernardino, California maintains ten. Some are located in residential sections and housed in buildings that harmonize with surroundings. Multiple plants make it possible to maintain more equal pressure under peak loads and prevent interruption of service over the entire system. San Bernardino recently modernized one of its plants and built one new station.

Low initial cost plus low maintenance cost that results from improved design and precision construction have made F-M Pumps standard wherever pumping equipment is used. The F-M line is complete. You describe the problem—we have the right pump for it. Fairbanks, Morse & Co., Department 118, 600 S. Michigan Ave., Chicago, Ill. Branches and service stations throughout the United States and Canada.



At the left is the neat layout of the new F-M equipment installed in the new Mt. View station—one F-M 6" x 8" horizontal booster pump direct connected to a 75-h.p. F-M Motor.

7671-PA98.17

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Pumps

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 80-83.

from an average of 8.82 million gallons per day to 2.8 million gallons per day. In other words, losses amounting to 6 million galons daily had been found and corrected. The saving by the elimination of this waste has been computed at $1,881,526 for the first five years the continuous leakage survey plan was in operation. The total cost of the work for the same five years amounted to $52,169. In the first year the water saved, at the current selling price, amounted to $145,-953; in that year 119 leaks were located and repaired.

Equipment used by the leak detectives consisted of a metal rod and an earphone. The rod is placed on the stem of each valve and the earphone on the end of the rod. A leak is indicated by a characteristic sound, readily recognizable. It was stated that men trained in this work have detected leaks in ½-inch service lines as much as a block away. The leakage detection campaign is supplemented by having the meter readers check all customers services for leaks.

Equipment for Measuring Flows and Detecting Leaks

Leak Detectors.—These all operate on the basis of the noise made by water escaping through a leak. The simplest is the aquaphone (also called "detectaleak," "sonoscope," etc.), somewhat similar to a stethoscope. Placed in contact with a hydrant, service box, etc., it transmits noise carried by the connected pipe. It can be used for testing for leakage in mains by driving an iron bar down to contact with the main and placing the aquaphone against the bar.

For locating the sound made by leaks through the earth, there is a device, variously called "leakfinder," "geophone," "leaklocator," which consists of two discs connected to headpieces by heavy rubber tubes. The sound of leaks passing through the discs, when they are laid on the ground, is carried through tubes to earphones on the head pieces. The earphones have rubber nipples which fit inside the ear, shutting out other sounds.

In the "Universal" leak detector (Water Leak Detector Co.) the intensity of the sound vibrations is measured on a dial, the reading of which increases as the microphone approaches the leak.

Pitometers.—For ascertaining whether a system is probably wasting or losing water, continuous measurement of flow in mains is made. Permanent or temporary meters are used for this purpose; or "Pitometers" are inserted in the main through 1" corporation cocks tapped into the top. The two pitometer orifices are connected to a glass U-tube, which may be set up in a manhole or on the surface above the connection. The flow can be read on the tube scale, but a continuous record for a day or more is desirable. This can be made by manually sliding an indicator up and down as the liquid in the tube rises and falls; or, a photo recorder can be used which gives a continuous photograph on moving sensitized paper of the position of the liquid meniscus in each leg of the U-tube. Or a record can be made on a circular chart.

Meter-Masters.—For detecting leaks in an individual building as well as making a general study of varying rates of consumption, "Meter Masters" are coming into general use. They will show also a record of the water passing through permanent or temporary meters used to measure the water passing into a section under test, through a by-pass around a closed gate or through a fire hose between two hydrants.

Valuable and interesting comments were made by our collaborators on various of the points covered by ths article. These will appear in an early issue.

ACCURATE LOCATION OF WATER LEAKS

"UNIVERSAL METHOD"
SIMPLE TO OPERATE

"UNIVERSAL" — WATER LEAK DETECTORS
PIPE LOCATORS

WRITE FOR BULLETIN No. 72

WATER LEAK DETECTOR COMPANY, 166 N. 3RD ST., COLUMBUS, OHIO

The floating bridge under construction showing barrels and timber construction, including ramp.

Vermont Builds a Floating Timber Bridge

Some design and construction factors involved in this unusual type of structure

THE tradition of a floating bridge across Colt's Pond at Brookfield, Vermont, was continued when the State Highway Department erected the fifth bridge of this type to be built there since 1812. Just why the first pontoon bridge was built is not known, but many people are attracted to the village to see this rather unusual construction. Therefore, when renewal became necessary the floating bridge type was maintained.

The new bridge is designed for the H-10 loading and for an expected life of some fifty years. All timbers were pressure treated with a final retention of 10 lbs. of creosote per cubic foot, in accordance with standard specifications, and galvanized hardware was used throughout. The vehicular roadway is 12 ft. between curbs and there is a 3-ft. sidewalk on either side of the bridge.

The float is 294 ft. long, securely moored to deadmen in the bank at each end, and supported by 380 oak barrels of 50-gallon capacity which serve as the pontoons. These barrels are heavily tarred inside and out to increase water tightness. The unit contains six lines of stringers. The four interior lines are 12 x 12-in. and the outside lines 6 x 12-in. timbers. Cross timbers or floor beams are 12 x 12 in. in size and spaced on 10-ft. centers, thus dividing each panel of the framework into five bays with a length of 10 ft. and a width equal to the spacing, edge to edge, of the stringers. For interior stringers this spacing is 3 ft. 2 in., or 2 in. greater than the length of the barrels used as pontoons. In each of the three interior bays three barrels are placed transversely with the bridge. The outer bay on each side, immediately under the sidewalk, has a width of only 2 ft. 6 in. In these outer bays two barrels are placed longitudinally with the bridge. There are, therefore, 13 barrels in each 10-ft. section.

Four round rods one inch in diameter are stapled across the under side of the four inside stringers in each bay, and to these are attached chains which pass over the barrel tops. In the outer bays under the sidewalks, where the barrels are placed at right angles to those in the interior bays, similar rods for fastening the chains pass through the cross timbers and run longitudinally. These chains transfer the bridge weight to the barrels to float the structure.

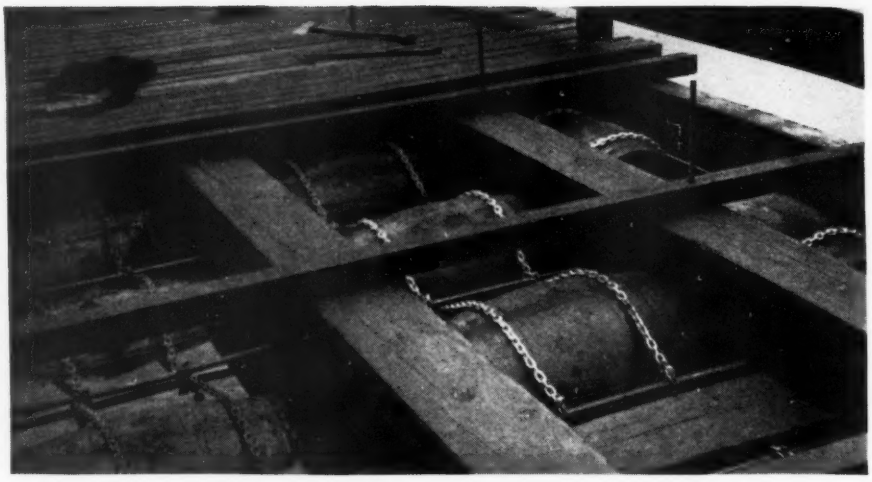
Thirty-foot ramps lead down from crib abutments on each bank to the floating portion. The ramp ends rest on the float 17 ft. from the ends, thus providing sufficient buoyancy to prevent objectionable settlement as the load passes onto the float.

The pond is small and well sheltered from the wind. The water level remains fairly constant, varying from 3 to 4 ft., which makes it easy to keep the bridge in position. Such variations as do occur in the water level are compensated for by a flexible sliding joint at the ramp and float connection. Three 12 x 12-in. cross timbers are placed side by side across the float along the under side of the stringers at the point where the ramp end is supported. Tops of these are armored with ½-in. steel plate. The float end of the ramp stringers is framed on a 9-in. radius and armored with steel nose plates, so that considerable sliding can take place as the floating section rises or lowers with the water level. To prevent crowding of the floor, a 7-in. gap was left in the floor at this point. Heavy traffic plates, connected to form a giant hinge, span this portion and permit the necessary play without crushing the floor plank. The hinge leaves are two checkered plates ¾ in. x 1 ft. 9 in. x 21 ft., milled to flex around a 2-in. round pin. The leaf on the ramp is fastened solid with lag screws, while the float leaf is free to move.

The floor is made up of 4 x 4-in. plank, laid with ¼-in. open joints, and the curbs between the sidewalk and the vehicular roadway are 8 x 10-in. timbers. Bolt and drift pin holes in these timbers and in the floor plank were bored before treatment. Where splices occur in the stringer system, joints were reinforced

by 6-ft. lengths of 12-in. channels used as fish-plates across the butt joints made at the stringer ends. Thus the stiffening truss effect of the framework is considerably increased. A total of 72,500 bd. ft. of creosoted timber was used in the construction of the bridge and the crib abutments.

The design and construction of this bridge were under the general direction of A. D. Bishop, State bridge engineer of the Vermont Highway Department; H. E. Sargent is commissioner of highways for Vermont. The data and illustrations were furnished through the courtesy of the American Wood-Preservers' Ass'n.



Chains fastened to iron rods and passed over the barrels carry the bridge

Short School Instruction Methods and Procedures

(Continued from page 15)

advantage, but this also should be secondary to the purposes of the school.

Results of the Georgia School

The results of the work of the Georgia Short School are summarized by Mr. Weir, as follows: Improved operation, increased tenure of office by the operators, financial savings to the communities through better operation, and an increased attraction to industries through furnishing a better quality of water.

Improved operation is pictured by the laboratory records over the past years which clearly show an improvement in the bacteriological, physical, and chemical quality of water produced. Plants are operated better and are returning better dividends on the money invested in them. Corrosion has been largely stopped; red water is now rare; bacterial counts are lower. More plants now keep adequate records. Many more operators are maintaining better technical control of their plants. Laboratory control tests are no longer an oddity. Fewer records are kept in the operator's hat but instead are in usable files where they should be. In general, a larger factor of safety has been applied to water and sewage plant operation.

The increased security in holding jobs is illustrated by the fact that during recent years practically no town has "slipped back" by discharging a capable operator. Savings on amounts of chemicals used and on plant maintenance and upkeep costs have resulted, especially in the smaller communities. Industries that require water in plant operation are attracted. It is a real initial saving to them not to be obliged to install an adequate water treatment plant solely for their own use.

The attendance at the school increased from 60 in the first year to 263 in 1939. In this the Georgia Water and Sewage Association has had an important hand. It has set up a board, given examinations and issued certificates which are highly valued by the operators and which often affect the jobs they hold.

The general instruction program is set up each year in advance by the Association board, and possible instructors are suggested by them. The Association edits "Drippings," which contains few technical papers because its function is essentially instruction and not the encouragement of the preparation of technical papers.

The Sanitary Engineering Division of the State Department of Public Health is called on for, and furnishes, placement service. It maintains directly, and also through the Association, a close touch with all operators and with their problems and needs.

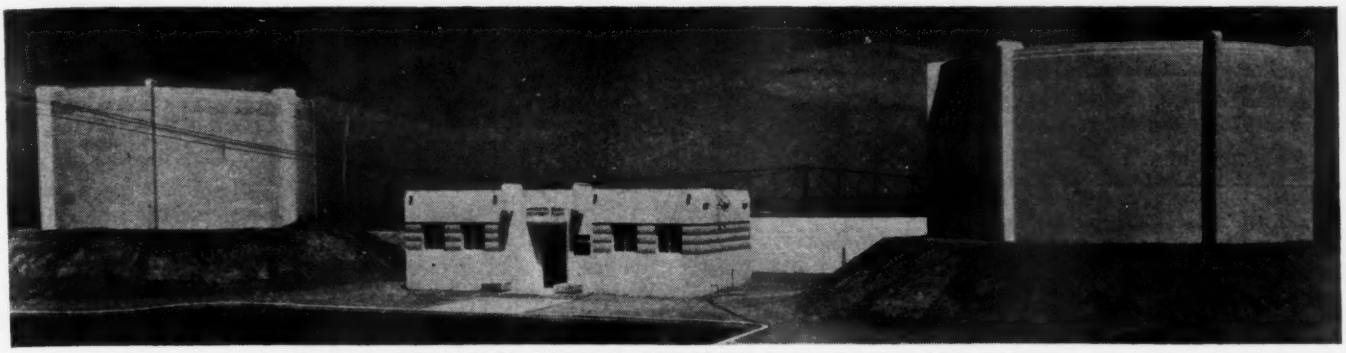
No successful state training program, says Mr. Weir, can be handicapped with competing schools. A policy regarding schools and a place to hold them should be adopted on a state-wide basis and carried out on a cooperative and mutually helpful long range plan. And any school to be successful must plan its instruction carefully and direct and control its instructors.

Federal money is available for adult education. Texas has arranged through the State Board for Vocational Education for traveling instructors to give training to water and sewage plant operators and has tied this work very effectively into the work of the Bureau of Sanitary Engineering and the Texas Short School.

Cast Iron Liner Plates Protect New Orleans Sewer

Curved cast iron plates were used to repair a pressure sewer in a recent project undertaken in New Orleans, La. The sewer had been in service for more than 30 years and the bottom had become worn by action of abrasive debris to such an extent that the original pipe thickness of 1⅛ inch had been reduced to ¼ inch in places. This resulted in leaks and loss of pressure to the system which necessitated an immediate repair or replacement. The replacement cost was estimated at $700,000, and in view of this high cost it was decided to find some method of repair.

Experiments were conducted to find a suitable material with which to repair the sewer. Concrete met the scouring test but failed to withstand the necessary pressure. A curved cast iron plate fastened to the inside bottom of the sewer with wrought iron pins was finally chosen. With these plates, and a crew of six men and a foreman, the sewer was successfully repaired in six months' working time at a cost of only $50,000.—Amerian Public Works Ass'n.



Huntington Beach, Calif., treatment plant; Currie Engrg. Co., consulting engineers.

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

Activated Carbon Aids Sludge Drying

Plants scale tests were made on the 40,800 sq. ft. of sludge-drying beds at Lancaster, Pa., in drying digested sludge drawn from storage tanks, in an effort to reduce the drying time from the average of 35 days. Applying 5.59 lbs, of alum per cu. yd. to the sludge at the point of discharge onto the drying bed, gave greater reduction of moisture but the total drying time was not increased. Tests on small (4 sq. ft.) beds with activated carbon dosed at 1% of the volatile solids present indicated very definitely that activated carbon treated sludge dried more rapidly; the use of activated carbon would cost only $3 per bed (4,080 sq. ft.). A plant scale test was then made, but by misunderstanding of instructions 14.1″ of activated carbon sludge was applied to one bed but only 9.4″ of untreated sludge to the parallel one. The activated carbon was added in a slurry to the sludge as it was withdrawn to a conditioning well and pumped to the drying bed. In 24 days the carbon-treated sludge showed a moisture reduction of 26.21% as compared to 20.11% in the much shallower untreated sludge.[H15]

Trade Effluent Disposal in England

Under England's recently passed Public Health Act the occupier of any trade premises has the right to discharge any trade effluent from his premises into a public sewer, "Trade Effluent" being defined as "any liquid, either with or without any particles of matter in suspension therein, which is wholly or in part produced in the course of any trade or industry carried on at trade premises." But the local authority may impose conditions or even refuse consent, from which the producer of the effluent may appeal to the Minister of Health. The conditions may include the fixing of the period or periods of the day during which effluents may be discharged into the sewer; requiring elimination of any constituent which would injure or obstruct the sewer or add considerably to the difficulty or cost of disposal; or cause obstruction to navigation in the diluting water; fix a maximum amount per day and rate at which it may be discharged; regulate temperature and require that, so far as is reasonably practicable, the effluent shall be neither acid nor alkaline; collect payment for receiving the effluent based on both volume and composition of the effluent; require provision and maintenance of inspection chambers for taking samples of effluents and meters for measuring them.[D11]

Power From Sludge Gas

Where gas is used to generate electricity, power conversion efficiency seldom exceeds 83%. Better efficiency is obtained by directly connecting the engine to the pump or blower. In many plants it is possible to direct-drive the large units, and also to generate current for driving the smaller and more distant units.

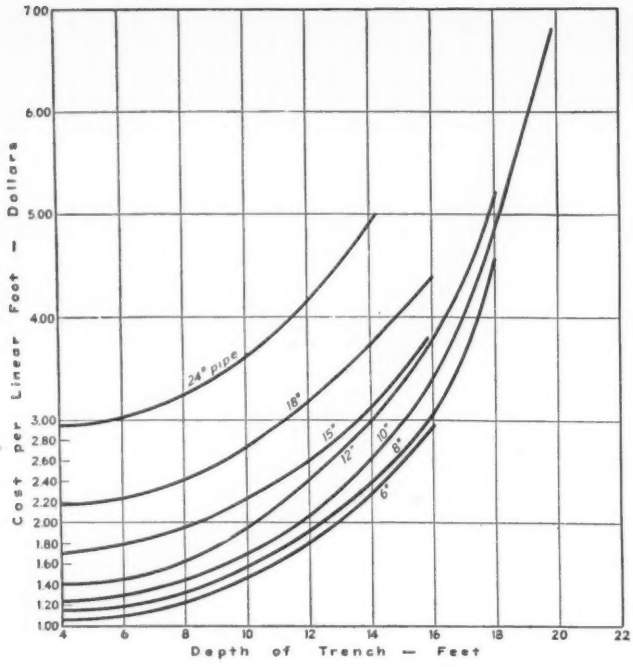
Where the volume of gas available fluctuates widely the engine is often fitted with an induction generator—essentially a squirrel-cage motor operating slightly above synchronous speed. They require an A.C. source of excitation. Another type is the conventional alternating current generator and exciter operating in parallel with the public utility lines; used for units, up to 200-kw generation capacity.

Because sewage works gas engines should operate with minimum attendance, it is desirable to use a protective system which observes and reacts faster than any attendant could. The most common of these is one in which pressure switches are put in the lubricating oil and the cooling water systems, supplemented by an overspeed trip. Should the engine attempt to run away, the water pressure drop, or the oil pressure fall, the engine stops at once, or a siren or howler is set off.[C31]

A Submarine Intercepting Sewer

As a part of a recently completed sewage disposal project, New Haven, Conn., has laid 4700 ft. of 36″ intercepting sewer in the water of the harbor close to the western shore, instead of in trenches on land. This permitted laying the sewer in a straight line, and therefore shorter and with a better grade (0.11%) than if it followed street lines, and eliminated deep and costly trenching.

In laying it, a trench was dredged and in it were driven piles at 12 ft. intervals in two lines 5 ft. apart, capped with 6″ x 12″ x 6.5′ timbers. The pipe was lowered cnto these and held in place by galvanized steel straps bolted in place by a diver. The pipe—36″ U. S. lock-type joint—was delivered by barge and unloaded into the water for storage until laid. It was jointed up on a barge, on skids 30° with the horizontal, the 3° deflection permitted by each joint making this possible; the barge being moved forward 12 ft. as each joint was completed. Test for tightness showed an infiltration during a complete tidal cycle of an average of 6.7 gph—1% of the specified limit.[X1]



Unit cost of vit. tile sewers, 6" to 24" at various depths. Chart from Engineering News-Record.

Cost of Laying Sewers

Contract prices on PWA work for laying vitrified pipe sewers in 24 jobs in New York State let in the latter part of 1938 have been tabulated and the averages plotted. The curves shown in the diagram are based on these. The pipes varied in size from 6" to 18", depths from 6 ft. to 18 ft. Prices include furnishing the pipe, excavation, laying and backfilling. Common labor in most places cost 50 cts. an hour, pipe layers 60 to 65 cts., machine operators $1.25 to $1.50. Pipe delivered in New York City in December cost 29 cts. for 8" and 57 cts. for 12".

Allowances for trench depth varied considerably in different places and with different contractors. One bid for 8" pipe was $0.95 for 6 ft. depth and $6.50 for 18 ft.; while on another job the contract price for a 6 ft. trench was $1.50 and for an 18 ft. trench $2.00. In most cases the cost of excavating and backfilling increased approximately as the depth between 8 and 12 or 14 ft., and then much more rapidly.[E10]

Plant for a Small Northern Village

The plant for Lake George Village, N. Y., is designed in three divisions to provide for a population of 1500 in winter, and a maximum of 5000 in summer. Of the three trickling filters, the one used in winter is covered by placing on the sand wooden horses 5 ft. high and placing a roof of 1¼" rough boards on these. Last winter the temperature under this roof was 36° when that outside was 18° below. The final effluent is discharged onto an area of 72,000 sq. ft. of natural sand more than 25 ft. deep and disappears.[G14]

A Chlorine Deficiency Alarm

At Great Neck, L. I., an alarm gong and light notify the operator when the chlorine cylinder is empty. A contact post is set in the face of the chlorine pressure gauge at zero and wired to an ordinary doorbell transformer. When the gauge needle falls to zero it contacts the post and the lamp (in the laboratory) and the gong (outside the building) operate.[G15]

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Hibbing's New Treatment Plant

The treatment plant of Hibbing, Minn., placed in service Dec. 15, contains several novel features. One is the elliptical monolithic concrete domes covering the two trickling filters. (See the "Digest" for December 1939). The population, at present about 18,000, is not expected to increase and the plant was designed for 20,000. Primary sedimentation is preceded by flocculation without chemicals. Digestion is two-stage, and both digesters are provided with heating coils. Superstructures are provided for all clarifiers, flocculator, chlorinating basin and pump house, as well as the filters. That over the chlorinating basin is used as garage and storage space. That over the pump house contains laboratory, office, toilet and equipment rooms. Equipment was furnished as follows: flocculator, primary and secondary clarifiers, sludge digesters, filters and sludge pumps by the Dorr Co. Comminutors, Chicago Pump Co. Motors and control, General Electric Co. Chlorinator, Wallace & Tiernan. Sewage meter, Bailey Meter Co. Heating boilers, Am. Radiator Co. Flame trap and waste gas burner, Pacific Flush-Tank Co. Gas meter, Pittsburgh Meter Co.[G13]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

D *The Surveyor*

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10. Sewerage and Sewage Disposal in 1939. Annual Review. Pp. 68-72.

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11. Drainage of Trade Premises: Act of 1937. Pp. 145-147.

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12. *p.* Operation of Oldham's Purification Works. By J. Taylor. PP. 167-171.
13. Septic Tank Design for Small Plants. By L. F. A. Maddocks. P. 173.

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14. *p.* Deterioration of Concrete in Contact with Sewage. By S. S. Morris. Pp. 183-184.
15. Sewage Disposal in Canada. By A. E. Berry. Pp. 193-194.

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16. *p.* Wakefield Sewage Works; Notes on Operation. By L. J. Artist. Pp. 215-217.

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17. *p.* Wakefield Sewage Works. Discussion of D 16. Pp. 235-237.

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9. Pointers on Sewage Disposal Service. By P. A. Smith. Pp. 71-73.
10. Cost Data on Clay Sewers. By M. W. Hayes and I. W. Mendelsohn. Pp. 73-74.
11. *p.* Sludge Filtration and Incineration. (Buffalo and Minneapolis-St. Paul). Pp. 75-78.
12. *p.* Sewer Maintenance Hints. By R. S. Nelle. Pp. 78-79.
13. Notes on Sewage Disposal. By W. Rudolfs. P. 80.

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11. Industrial Waste Disposal: Review of Developments in 1939. By F. W. Mohlman. Pp. 93-101.
12. "Package Delivery" Waste Treatment Plants. By E. B. Mallory. Pp. 102-106.
13. New Treatment Plant of Hibbing, Minn. By C. Foster. Pp. 115-119.
14. Complete Sewage Disposal for Lake George, N. Y. By M. Vrooman, Jr. Pp. 130-133.
15. A Simple Chlorine Deficiency Alarm. By H. O. Johnson and F. M. Jablon. P. 135.

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15. Activated Carbon Aids Sludge Drying. By G. J. Wiest. Pp. 140-142.
16. Chlorination Eliminates Odors at Ocean Boardwalk Plant. By J. Strahan. P. 142.
17. Activated Sludge Plant Corrects Pollution Litigation. (Leominster, Mass.) By E. S. Chase. Pp. 143-146.
18. Sewage Treatment Plant of Greece, N. Y. By H. S. Thomas. Pp. 154-156.

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7. Well-Landscaped Sewage Works of Bloomington-Normal, Ill. By J. L. Hasbrouck. Pp. 37-38, 81.
8. Malvern, Ark., Builds New Sewage Works. By D. Y. McDowell. Pp. 46-47.

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1. *p.* Sewer Rental Financing. By W. Storrie. Pp. 46-55.

P *Public Works*

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18. Incinerator Replaces Dump and Permits Development of Boat Harbor and Playground. By H. W. Taylor. Pp. 14-16.
19. *n.* Spring Housecleaning at the Sewage Treatment Plant. P. 18.
20. *n.* Spray Nozzles to Remove Imhoff Tank Scum. P. 18.
21. Trickling Filter Design, Construction and Operation. Pp. 23-29.
22. Sewer Infiltration and Its Measurement: A Symposium. Pp. 40-41, 44, 45.

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1. Influence des Travaux d' Hygiene Publique, Urbaine et Rurale, Sur l' Etat Sanitaire des Populations. By M. Moine. Pp. 2-9.

X *The U. S. Piper*

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1. *c.* Submarine Intercepting Sewer Laid in Harbor, New Haven, Conn. Pp. 3-6, 18.

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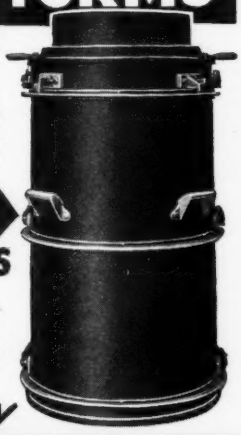

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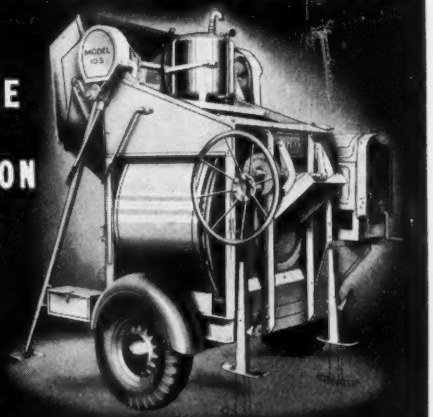

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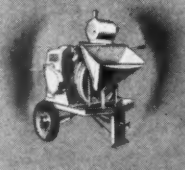

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The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Porous Plate Filter Bottom

Because of the formation of mud balls, including carbon, in the filters of the Ford Motor Co., Flat Rock, Mich., plant, believed to be due to the nonuniform distribution of wash water by the gravel, the filters were rebuilt with bottoms of "fused alumina plates," pore size averaging 0.4 m m diameter, passing 50 cu. ft. of air per min. under 2″ pressure, supported by cadmium plated steel bars resting on the distributing laterals, to which they were welded. The plates were fastened to these by phosphor-bronze bolts, washers and nuts. These gave entirely uniform expansion of sand and a higher wash water rate. Also, removing the gravel gave a higher freeboard.[G11]

Cathodic Protection At Treasure Island

Treasure Island, San Francisco, is an artificial island made by dredging from salt water and the soil is an exceedingly heterogeneous mixture of almost salt-free sand, local thin clay sheets, and highly corrosive and electrically non-resistant moist salty clay balls. This condition produced rapid local corrosion by pitting in bare and asphalt-dipped steel pipe but not in asphalt-dipped pipe that had been wrapped with asphalt-impregnated felt. The maximum rate of pitting was 0.168 in. per year and the average 0.107 in.

This excessive corrosion, affecting 8 networks of utility pipes totalling 33.6 miles, has been controlled economically by application of cathodic protection. The number of new leaks discovered per week in the domestic water system, which was the most vulnerable, was reduced from 15 to zero, and corrosion in all the pipe systems was effectively controlled. This was accomplished by the installation of six rectifier stations with an output of approximately 460 d.c. amperes giving current density of 10 milliamperes per sq. ft. of equivalent exposed base pipe surface. Rectifiers at cathodic protection stations having anode pipes with external surfaces in contact with saturated sand sufficient to give an average current density of 0.10 amperes per sq. ft. experienced no decrease in output over a period of one year. Those with greater current density showed a steady decrease in output during the same period.

The cost of installing 570 amp. capacity of cathodic protection, including equipment, labor and testing, was $12,400. The cost of repairing leaks due to corrosion was at the rate of $9,750 a year and was increasing rapidly.[A57]

Ozone Treatment At Delhi, N Y.

Our attention has been called to the fact that in an item under this head which appeared in the March Digest, the advantages of the ozone process, as listed by Mr. Cox, were inadvertently omitted, though the disadvantages were given. Advantages listed were: (1) disinfection of the water without the disinfectant imparting a taste; (2) effective oxidation of many taste producing compounds; and (3) removal of some color by the bleaching action of the ozone. We are also informed that this installation, made a number of years ago, and by a company no longer in the municipal field, does not represent modern practice, which involves the use of a pilot plant to determine ozone demand and other factors in design.[B13]

Apparatus for Calcium And Magnesium Determination

Description of a motorized laboratory apparatus which aerates and permits the continuous addition of soap, in a modified Clark soap test; and the development of a new technique for the direct determination of calcium and magnesium in water, either separately or combined.[A55]

Induced Turbidity improves Flocculation

The well water supply of Ypsilanti, Mich., has an iron content of 1.6 ppm and total hardness of 395 ppm. This water is aerated and well mixed with lime and soda ash, and coagulated by slowly moving paddles, settled and filtered. At first, using 15 gr. per gal. of lime and 1.5 gr. of soda ash, the hardness was reduced to 126 ppm, but the filter sand clogged and runs of about 16 hrs. were the best obtainable. To secure more complete settling of suspended matter before filtering, sludge from the settling tank was fed back to the mixing tank with the chemicals, and clarification so improved that filter runs of 60 to 70 hrs. are now the rule, and a slight increase in the chemicals brings the total hardness to 90 ppm.[J9]

Toledo's New Intake Crib

A crib for the water works of Toledo, O. is being built in Lake Erie about 2½ miles from shore in 22 ft. of water. For protection during construction from the prevailing N E winds, the contractor sunk a 400 ft. lake freighter filled with sand. When resting on the bottom it extended about 10 ft. above the water. There was room between it and the crib site to permit pile driving barges to work driving the steel piles for the cofferdam, which piles were stored on the sunken freighter. The coffer dam consisted of 13 circular cells 30 ft. in diameter, filled with sand. When this had been completed early last winter the freighter was pumped out, floated and removed; and it was planned to replace it this spring, as soon as ice conditions permit, pump out the cofferdam and construct the intake in the dry.[F31]

The chief problem in designing the crib was occasioned by the necessity of combating frazil ice and pressure ice. Pressure ice is that caused by wind

Ewing Galloway

April showers bring forth May flowers

THEY also bring an accumulation of impurities into the water supply necessitating constant supervision in order to deliver to the consumer a safe and palatable water at all times. High turbidities result from heavy run-offs of water; and tastes and odors occur from flushing out accumulations of leaves, decayed vegetation, etc., which have built up in swampy and stagnant areas over the winter season.

THIS is therefore a season of the year when trouble may come in big bunches. Make preparations now to take care of these problems by anticipating your chemical supplies; not forgetting AQUA NUCHAR, the Activated Carbon for taste and odor control.

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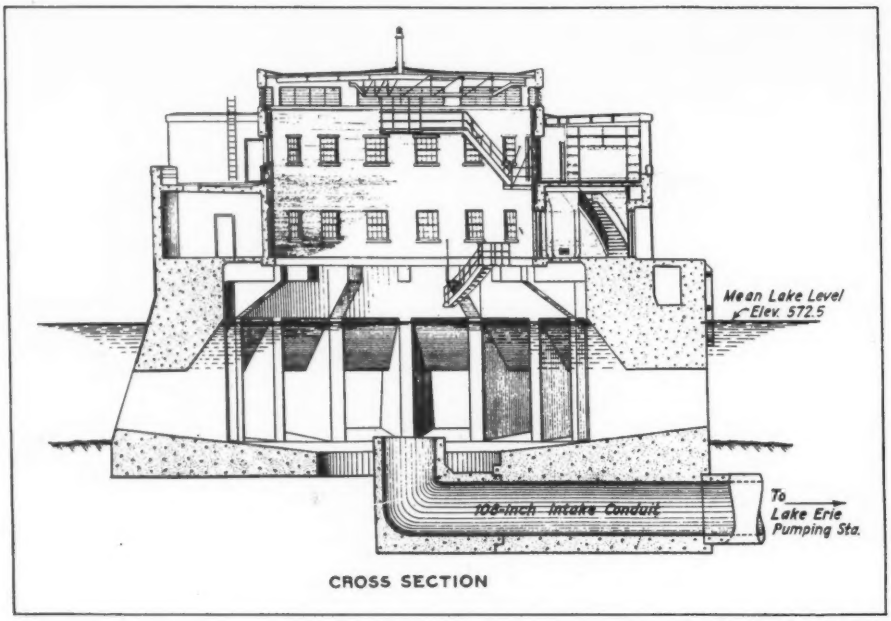


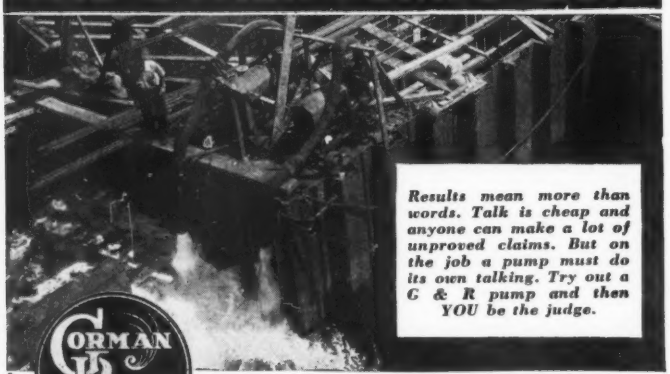
Section of Toledo Intake Crib Courtesy Water Works Engineering

blowing sheet ice into windrows, which may extend to the bottom of the lake, and completely cover a submerged intake. Therefore the intake is to extend above the water. The intake ports are made very large and as far below the surface as practicable, giving an intake velocity not exceeding 0.25 fps. Frazil ice will be dislodged by pike poles from the inside of the intake and brought inside, to be melted in the conduit by the natural heat therein. Pressure ice can generally be dislodged by light charges of powder or dynamite, by men who will live in the intake's superstructure during severe weather; food being stored there to maintain four men for several months.[F30]

Record of Water Works Operation

Eight articles, occupying 97 pages of the February issue of the A.W.W.A. Journal, are devoted to discussing the value, keeping and use of records. The first is the (copyrighted) report of a committee of the association setting forth in detail "recommended practice" for distribution system records (not to be interpreted as a standard practice), evolved from a study of many successful record procedures now being used by different utilities, using the best parts of each, with the practical details simplified to the point considered as the minimum that will give the necessary records. The aim is two-fold: To provide permanent records of the physical assets of the distribution system structures of the water works; and to provide practical, systematic records necessary for the efficient operation of that system. The records are classified as mapped records, card records, statistical records, work orders and reports, maintenance records, and records for small systems; also standard symbols and drafting suggestions.[A47]

THE OTHER PUMPS QUIT



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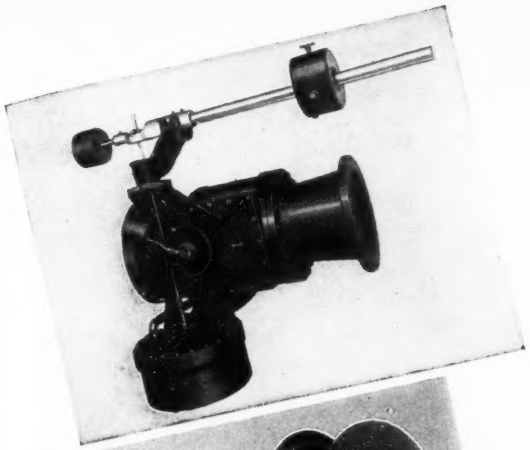

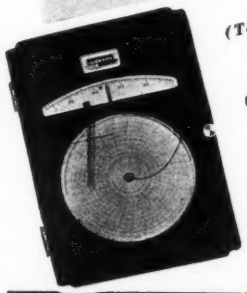

(*Top*) Type E Direct-Acting Controller

(*Middle*) Chronoflo Large Dial Gauge

(*Bottom*) Flo-Watch Register, Indicator, Recorder.

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Chronoflo Large Dial Illuminated Indicator **provides a useful and ornamental addition to the operating gallery. Mounting the entire mechanism on sturdy concealed double hinges allows the operator to make all adjustments without removal of dial or any working parts.** ***Bulletin 317***

Flo-Watch**—"The most attractive flow meter in the low price class" is the comment frequently expressed about the Flo-Watch. But its high accuracy, wide range, and sturdy construction are important, too!** ***Bulletin 303-A***

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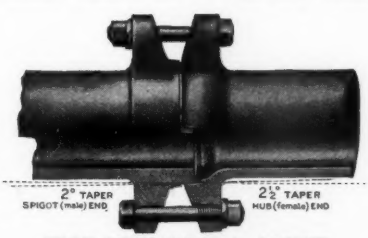

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This report does not cover accounting records, and N. B. Jacobs offers suggestions for coordinating these two branches, from the standpoint of reducing clerical work, producing better records, and providing a ready means of cooperation and coordination between the work of the two departments.[A49]

A member of the Municipal Finance Officers Ass'n discusses "Economies in Office Forms," saying that some offices have far too many forms; others could use the same number more economically.[A48]

Subjects of the other papers include "recording data in such form as may be readily available and easily proven in actions instituted to establish water rights or resist their invasion"; the value of department records in planning improvements to the system; consideration in detail of the several classes of records relative to supply and distribution; the value of treatment records and forms for keeping them—"Unless we keep complete and accurate records of all of our operations we will not be able to cooperate in furnishing the needed information for the compilation of complete national statistics which, when accomplished, will be of great value to all in the water works field," and the use of department records in promoting a favorable attitude of the public toward the water department.[A50-54]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Waterworks Ass'n.*
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47. Recommend Practice for Distribution System Records. Committee Report. Pp. 181-220.
48. Economies in Offic Forms. By I. Rafkind. Pp. 221-224.
49. Coordinating Operating System Records with Accounting Records. By N. B. Jacobs. Pp. 225-241.
50. Water Department Records and Legal Operation. By W. G. Irving. Pp. 242-246.
51. Improvement Requirements and Department Records. By C. P. Harnish and J. W. Ford. Pp. 247-254.
52. Department Records for Supply and Distribution. By H. A. Harris, Jr. Pp. 255-258.
53. Treatment Records and Their Value. By C. M. Hoskinson. Pp. 259-264.
54. Public Relations and Department Records. By H. B. Fisher. Pp. 265-278.
55. A Motorized Apparatus for the Rapid Determination of Calcium and Magnesium in Water. By W. F. Langelier. Pp. 279-293.
56. Hazards to Employees in Water Works Plants. By A. A. Soldner. Pp. 294-304.
57. Cathodic Protection on Domestic Distribution System at Treasure Island. By C. H. Lee. Pp. 305-338.

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1. Water Supply Engineering in 1939. Annual review. Pp. 67-68.

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30. Design of New Improvements for Toledo, O. By P. Hansen. Pp. 280-285.
31. Construction Features of Toledo's New Improvements. By O. E. Clark. Pp. 286-289.
32. *p.* Frost Penetration Estimated by Daily Average Temperature. By H. U. Fuller. Pp. 290-291, 299.
33. Service Installations in Small Water Works Plants. Pp. 303-304.

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11. *p.* Porous Plate Filter Bottoms. By L. R. Stevens. Pp. 111-113.
12. Air-Water Combination Wash. By F. C. Amsbury. P. 114.

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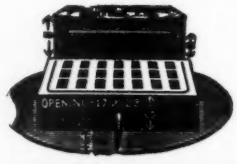

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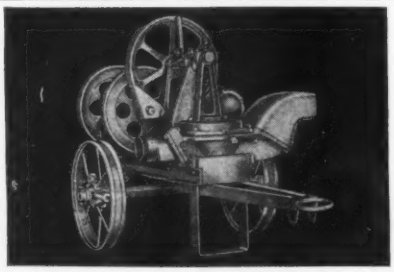

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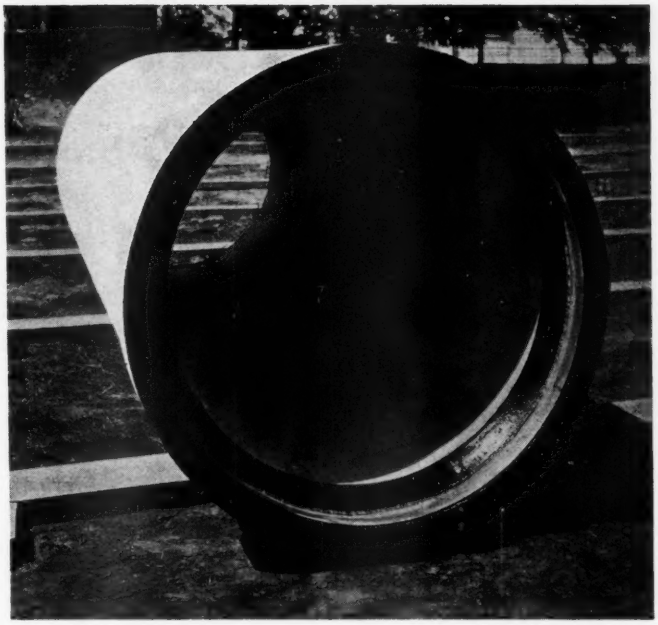

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By all standards the year 1939 was the greatest in the history of water works construction. Expenditures in all its branches greatly exceeded those of any previous year.

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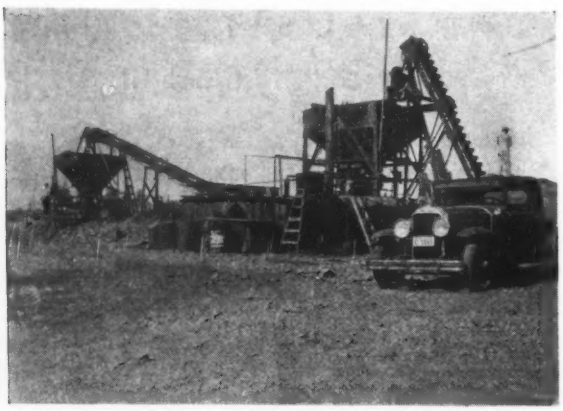
Factors in the Selection of Plant-Mix Surfaces for Michigan Low-Cost Roads

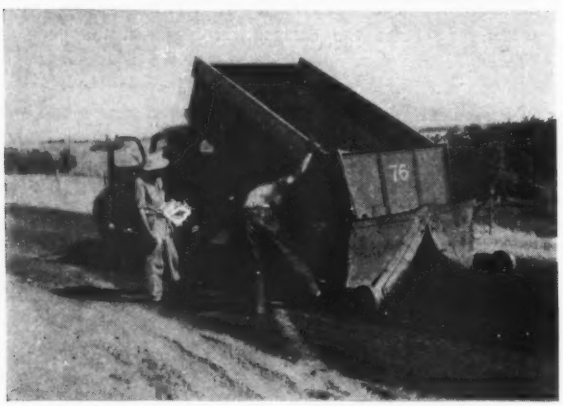
By J. G. SCHAUB
Engineer of Construction and Operations, Michigan State Highway

THE factors and conditions governing the selection of a type and method of bituminous surface course construction for secondary roads in Michigan are:

1. *Climatic Conditions.*—Due to severe winters and considerable rainfall through parts of the year, an open graded type of surface would not be suitable; rather a dense mixture to prevent infiltration of water and disintegration from frost action is desired.

2. *Character of Traffic.*—The predominant type of traffic, even in rural sections, is pneumatic tired and fast moving. This requires a smooth, dustless, yet non-skid surface, but permits the use of softer bituminous materials and mixtures, which would be affected by a large amount of iron tired traffic or sharp shod animals. Since Michigan's large tourist traffic volume is at its peak during the summer months, the importance of selecting a type of construction that will not seriously interfere with traffic flow must be considered.





Steps in Plant Mix Construction

3. *Available Aggregates.*—Michigan has generally available a large supply of sand-gravel aggregates, which can be cheaply prepared for dense graded bituminous mixtures, but are more costly for open graded mixtures because of the large amount of sand to waste. Stone deposits in the state, suitable for the production of crushed stone of a hardness and toughness required for some types of bituminous construction, are very limited. While the supply of sand-gravel aggregates is widespread, its quality is spotty and in many areas contains much soft stone. This condition indicates the use of a soft or self-healing bituminous material, which will enable fast moving, rubber tired traffic to heal over pitted surfaces during the warm season. Our limited lower grade crushed stone supply also fits this type of bituminous material.

4. *First Cost.*—On account of our large volume of seasonal tourist traffic, moving all over the state in search of recreation, a low first cost, durable, dustless surface is required to cover some three thousand miles of gravel trunklines as soon as possible. Therefore, it is important to use our low-cost aggregates with suitable bituminous material to provide a mixture that can be cheaply produced and laid.

5. *Maintenance Expense.* — Low cost construction must also take into account maintenance and upkeep expense. A type of bituminous surface that can be repaired readily and economically by the ordinary workmen and equipment of the Maintenance Division, makes possible a low maintenance expense. This again points in the direction of the soft, slow curing bituminous mixtures which can be stockpiled and handled without heating in warm weather. Due to this soft bituminous material, the surface can also be reworked in summer months, as was necessary on a few of our projects, due to settlement and breakups over unsatisfactory subgrade.

These are the reasons why we have selected the oil aggregate mixture for bituminous surfacing on our secondary system. It is a dense mixture to fit our climatic conditions. It provides a dustless, durable, non-skid surface for our automobile traffic. Our cheap available sand-gravel and stone aggregates are perfectly suitable for this mixture, which require only about 4% by weight of an inexpensive slow curing oil—SC6A. The aggregate contains about 50% by weight passing a 10-mesh sieve, but we also add a small amount of limestone dust as filler. The mixture can be cheaply manufactured in nearly all parts of the state, and the use of maintenance stockpiles provides low cost maintenance.

Since the oil aggregate mixture fits the Michigan picture, the problem of the best and most economical way to mix and lay it, presented itself.

Road or Plant-Mix

Both road-mix and plant-mix oil aggregate construction were laid by the Michigan State Highway Department first in 1935. Some additional road-mix was laid in 1936, but since then the entire oil-aggregate problem is confined to plant-mix construction. We have laid so far a total of about 750 miles and next year's program will involve about 250 miles more.

Many Michigan county highway organizations have successfully laid, and still continue to lay oil aggregate, and other types of bituminous surfaces, by road-mix methods with their own equipment and forces. The Michigan State Highway Department, however, believes that the contract system of road construction is the most economical and best suited for all interests and for the general economy.

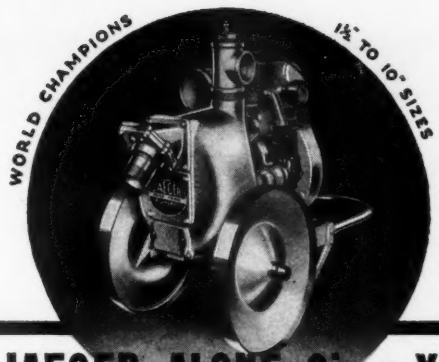
Road-Mix construction has some difficult problems for our conditions and some serious drawbacks under the contract system of construction. In the first place, the oil-aggregate dense-graded mixture, we believe, requires for durability a uniform gradation of aggregate from coarse to fine, including suitable 200-mesh material, and freedom from moisture—over 2% being harmful and less than 1% being desirable. The frequent rains of spring and fall limit good construction to the summer months, if road-mix methods are used. The delay and expense to a contractor, in long drawn out manipulation properly to blend aggregates and to free such windrowed aggregates from excessive moisture due to frequent rains, is considerable. Since the favorable road-mix construction season is in the summer months, when tourist traffic is at its peak, we were faced with the detour problem and annoyance to the tourist industry which is second only to the automobile industry in importance in our state.

Therefore we have standardized on plant-mix oil aggregate construction for our secondary roads. Most any standard batch type asphalt plant is permitted. We are securing uniformly graded mixtures, with carefully controlled oil content, by batch weight proportioning and mixing. The use of driers provide aggregates with less than 1% moisture and permit a much longer working season. In fact, we start oil aggregate construction as soon as the spring breakup is over and have laid as late as Christmas.

Construction Procedure

The gravel road surface is shaped to a crown of 1½" to 2" for the 20-ft. wide surface and to proper grade to insure good riding quality. This is accomplished with patrol graders or maintainers when the proper moisture condition in the gravel surface is present.

The base is then primed, one-half width at a time, with about ¼ gallon per square yard of cut-back asphalt or tar prime. After the prime has cured, the oil aggregate mixture is spread one-half width in two layers by means of mechanical self-propelled spreaders, such as the Jaeger, Barber-Greene or Adnun. Inequalities in the base are greatly reduced by the two layer method, possible with these types of spreaders and better compaction is obtained. The compacted thickness is approximately 2½", obtained by using 250 pounds of mixture per square yard. A tandem roller of 5 to 8 tons weight, rolling only once or twice over to close the surface, is required. Traffic assists in providing compaction and is encouraged to use the freshly laid surface after the roller has passed over once.



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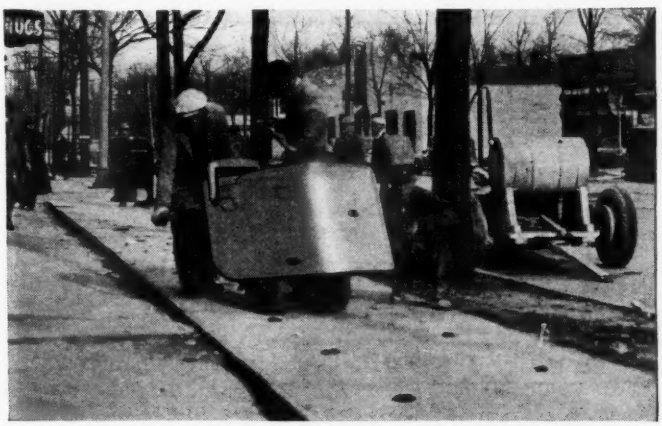

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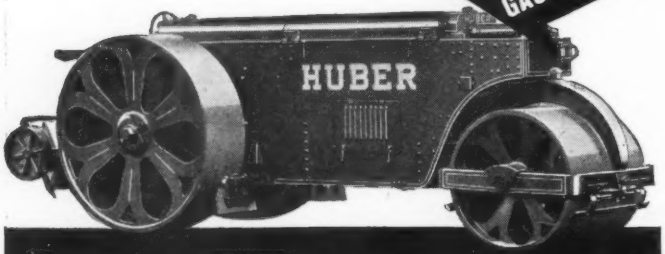

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This method of laying the surface interferes very little with traffic flow, as only around the machine and a short distance behind, is one way traffic necessary.

Spreaders can readily handle one hundred tons per hour. Plants having a one-ton mixer box can satisfactorily produce an average of fifty to sixty tons per hour. The mixing time required thoroughly to coat the aggregate is generally ten seconds for the dry mix, and thirty-five seconds for the wet mix. Contractors frequently work two shifts at the plant, stockpiling the mixture during one shift and hauling from both plant and stockpile to supply the spreader during the other shift, thus securing the economical advantage of the spreader's ability to lay more than the one-ton plant can produce. All mixtures are weighed on approved and State tested platform truck scales to determine pay quantities. The contractor provides the scales and the State the weighmaster, also a field laboratory at each plant, with trained inspectors to insure uniform quality.

The average bid price for the 1938 program was $3.29 per ton for the oil aggregate surface laid complete. For the 1,500 tons per mile which we use, this gives a cost of $4,935.00 per mile. In 1939 the bids averaged $3.10 per ton, which is $4,650.00 per mile. The highest price in the 1939 program was $3.95 per ton and the lowest $2.75 per ton. Cost of aggregate and length of haul were the principal factors causing this variation.

This material is condensed from a paper by Mr. Schaub before the 1940 Purdue Road School and was furnished us through the courtesy of Prof. Ben H. Petty of Purdue.

English Aids for Traffic During Blackout Periods

Data issued by the Air Raids Precautions, London, England, and reported in Road Abstracts, include: The necessary requirements for aiding the movement of traffic under the "blackout" conditions can be met by the provision of—(a) screened traffic signals; (b) warning signs; (c) direction signs; (d) distinguishing marks on curbs and associated features (trees, posts, etc.) and on the highway itself; (e) obstruction lighting.

Details of these "aids too movement" are given. The red, amber and green lenses of traffic signals must be masked by an opaque disc leaving an aperture for the emission of light in the form of a cross 3 in. by 3 in. and ⅛ in. thick in the upper half of the lens. The masks should be made of thin, blackened sheet metal. Illuminated mandatory and prohibitory signs must be screened from above and so dimmed that, though legible under "black-out" conditions to drivers at 100 ft., they are inconspicuous at 250 ft. The brightness of the lettering should be reduced to the order of 0.1 candles per sq. ft. Signs of this type depending for their visibility on present lighting will require to be rendered visible. This may be done by a screened lighting unit at the top of the sign, throwing light downward upon the sign but not upon the ground. The color of the light must be white. "Keep Left" panels in bollards, etc., must be screened and dimmed to the above requirements. Colored panels must be replaced by white.

Island refuges not equipped with illuminated bollards must be treated as obstructions. Island refuges fitted with "Keep Left" bollards must be installed at wide junctions and intersections where there is no central island. Through routes traversing towns must be adequately indicated by illuminated route numbers and

advance direction signs. Consideration should also be given to the question of illuminating the names of important streets, where these street names are required for the guidance of traffic. Instructions are given for painting curbs at junctions, trees, posts, guard rails, etc., and traffic lines with white paint or white reflecting material where indicated. Obstructions on roads must be indicated by lights. Dimmed and well-screened hurricane lamps should be used and the candle power reduced to less than 1.

Highway Work and Stream Bank Control Experience

By H. C. WILLIAMS
County Engineer, Texas Co., Oklahoma

TEXAS COUNTY, size 34 miles by 60 miles, is the second largest county in the state of Oklahome and has, by over 1,000 miles, the most open section lines. According to the State survey in 1935 it had 3,096 miles of open section line or roads, of this number there were 1,071 miles that were on mail routes, and 599 that are on designated and numbered primary and secondary county roads. In 1935, Olkahoma passed a law throwing all county roads that were open and travelable into the county highway system and did away with the township roads. We do not levy any ad valorem tax for highway purposes in this county; only that derived from state gasoline tax and auto tag license is used and that is pro-rated as follows:

Gasoline tax of which the state levies 4c per gal. after January 1, 1940, is distributed as follows: 3% to the Tax Commission for collection, etc.; 70% to the State Highway Department; 5% to the cities; and 22% to the counties. In turn the counties shall distribute it as follows: 40% to the counties on the ratio their total road mileage is to the state's total, and 60% on ratio their area and population is to the State's area and population.

Auto tag: The following distribution became effective January 1, 1940: 10% to the Tax Commission for collections and expenses; 55% of the remaining 90% to the counties, on the same basis as the gasoline tax; 30% of the 90% to the State Highway Commission; and 15% of 90% to the cities.

This county has approximately 1,500 miles of graded roads and we have undertaken to elevate to a standard 30-foot roadway grade all the primary ones. Only since 1936 has the Panhandle counties of Oklahoma obtained any revenues to speak of. Prior to that time it was allocated on a basis of population of which we only have about 12,500—one of the smallest in the state. Our revenues will now run approximately $150,000 per year as against less than one-half that much prior to 1936.

We have been procuring considerable new equipment as the county did not have any when I started working with them in 1935, except for a few pieces of worn out equipment. Now we have 8 large motor patrols, 1 small one, four RD-7 tractors; three 42" elevators; two 5-cu. yd. Carryalls; two 60 H.P. Bulldozers; four 10 to 12-ft. graders, of which two are old ones; one all steel tower drop hammer pile-driver; one 1½-ton truck with 10-ton trailer and winch; and we are just getting in shape really to build some roads to standard grade.

A note on our stream bank trouble: In this county we have several creeks and rivers that you can jump across 360 days out of the year, but those other 5

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And, of course, brick best withstands the concentrated chain-shod traffic in snow-rutted roads or streets. The experience records of hundreds of cities and other road building units and many accelerated tests have definitely established that point.

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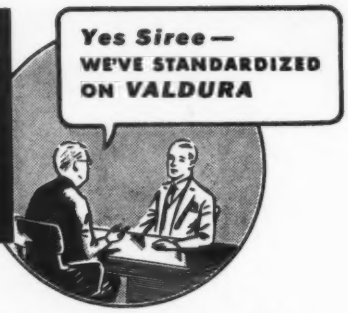

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days they would float a battleship if it had a shallow draft. We have three main streams that get as much as one mile wide and won't be over ten feet deep in the deepest channel. The recent drouth has stripped the soil of its vegetable stabilization matter and some of the water that came down in the first rise of the year before last weighed as much as 11 pounds per gallon —it had so much dirt in it almost as thick as molasses. Such floods cut away sandy banks and erode around bridges unless confined or else the bridge is several hundred feet long. I have been constructing from automobile car rails, of which there are two on each frame, a modified Keltner type of jetty. They are built like the Keltner type jetty and are wired with No. 11 galvanized wire, a double strand and then twisted between each member, which makes them very rigid. I connect them with oil 1 inch oil filled cable and clamp them on. I use a Lovejoy compress punch, punching holes in the frame with a ⅝ inch punch, and using ½-inch by 1-inch machine bolts. We use 4 bolts to the jetty and do not use any car rails smaller than a Chevrolet. It figures approximately 75c per running foot in place of which 50c goes in materials and 25c in labor. It makes an ideal W.P.A. job and is really a better jetty than the Keltner type. We have put in over 1,500 units in various places and where I have held my line they are really effective. It is important to see that the main cable lines are strong enough. I tried twisting six strands of No. 6 galvanized wire but I lost the jetties so I am now using either a double ⅝-inch cable or a single 1-inch. All streams where I have used this method have really been confined.

Getting Results From an Overcrowded "Horse and Buggy" Sewage Plant

In 1915 Schenectady, N. Y., put into operation a sewage treatment plant consisting chiefly of 9 Imhoff tanks and 3 acres of sprinklng filters. This was only half the size of the plant planned and it was 50% overloaded at the start; but, though Schenectady has grown, the plant has remained practically the same—no additional tanks or filters have been built, the bar screens are still hand-cleaned, the sludge beds are still exposed to the extreme winter weather experienced there.

In describing this plant in the April, 1915, issue of this journal (then called "Municipal Journal") we noted that, although Geo. W. Fuller had designed the plant to have Imhoff tanks with a depth of 25 ft., this was reduced during construction to 14 ft. 4 in. to reduce the cost of construction in the quicksand found, leaving the sludge chambers only 6 ft. deep below the slots. This has been a disadvantage that added to the difficulty of running the plant at 150% of its reasonable capacity—about 8.5 mgd, which is only about 60% of the city's sewage, the rest being discharged raw into the Mohawk river.

But with all its drawbacks, Morris M. Cohn has secured good results with this plant. Last year he made it remove an average of 88.9% of the B.O.D. and 79.6% of the suspended solids, the filter effluent containing 13 ppm of B.O.D. and 35 ppm of suspended solids. This certainly is an excellent illustration of the saying that a good superintendent can get better results from a poor plant than a poor superintendent does from a good one. Cohn certainly knows his plant inside and out; he even (by accident) actually dove into one of the Imhoff tanks a few years ago. Perhaps if the opera-

tion had not been so excellent, the city would years ago have built a bigger and better plant, as the State Health Department has ordered it to do.

With constant vigilance and careful operation based on past experience, the tanks are made to give good results in spite of their 50% overload; but their low sludge capacity and the fact that the sludge beds are all open, makes the sludge problem a serious one. The sludge drying season lasts from May to November, and during that period last year sludge was drawn as rapidly as possible, a total of 11,250 cu. yd. of wet sludge being drawn onto the 10 drying beds; but at the end of that period the tanks were still seriously loaded with sludge, and the sludge lagoon used in the past was filled with deposits of previous years. A dyke was built around this area, and approximately 2,000 cu. yd. of wet sludge was pumped into the lagoon during November and December. At the end of the year 300 cu. yd. of sludge remained on the beds and a considerable amount of air-dried sludge remained on the storage platform, from which it was hoped farmers and householders would remove it.

The cost of operating this "horse and buggy" plant was $16,800, or $4.82 per m.g. of sewage treated, or 17.5 cts. per capita served. Mr. Cohn is studying the sewer rental method of financing with a view to the adoption of it by Schenectady for financing the proposed improvements as well as the operation and maintenance of the plant and of the sewerage system.

Bond Tests on Rusted Reinforcing Bars

In an investigation by H. J. Gilkey, S. J. Chamberlain and R. W. Beal, of Iowa State College, reported by the Highway Research Board, plain round ⅝ in. steel bars were exposed to the weather for 0, 1, 2, 3, 4, 6, 7, and 8 months respectively. Rust formation was observed and measured by abrading the rust and weighing it. On companion bars the rust was: (a) left unmolested, and (b) wiped off with burlap. All bars were vertically cast into 10-in. 28-day pullout specimens (L/D=16) and observations were taken for "first slip," ultimate bond resistance and drag resistance after a slippage of 0.08 in. Amounts of slippage were measured at both the loaded and the unloaded ends of the bars. The general conclusions reached are that the light layer of loose powdery red rust that first forms is of negligible importance and that firm rust is not detrimental to bond resistance and may actually increase it. Wiping rusted bars off with burlap had no important effect, the tendency in these tests being to decrease the bond somewhat for early or short rusting periods and to increase the bond resistance appreciably where the rust had become deep, loose and flaky as it was for the bars which were exposed for eight months. In the eight-month exposure the rust was so deep that it was making inroads on the effective cross-section of the bar and was beyond what would be considered permissible regardless of its effect on the bond resistance.

Colleges Pay for Water

In 24 cities where state universities are located all state institutions but three pay the regular rates for water; in two cases they pay nothing; and in the other case about one-third of the regular rate is charged. All private colleges but one paid the regular water rate. In most cases all city departments pay the same rate as other consumers.

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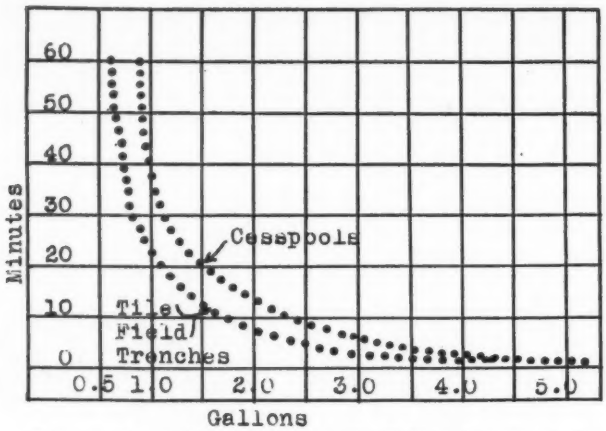
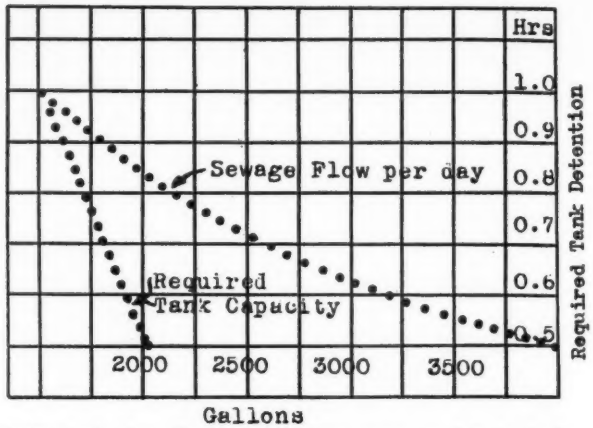


Curves of percolation rates for tile field and cesspool size determination.



Septic tank size: From sewage flow curve go left to tank capacity curve and down.

Design Notes for Camp, Residential, Hotel and Other Small Sewage Treatment Works

What method to use and the selection of design details for small installations are considered in the light of Eastern experience.

ITEMS to be considered in design and preparation of plans for small sewage disposal works, as for camps, hotels, boarding houses, cottages, small schools, etc., have been covered by instructions issued by the Division of Sanitation of the New York State Department of Health. These supplement Bulletin No. 1 of the Department and should be used in connection with that Bulletin.

General.—Plans should be drawn on a suitable scale and should show plant location; kind, size and slope of sewers; general slope of ground; a north arrow; location of wells and springs with distances to sewer lines and disposal works; capacity of buildings served; and details of the disposal system. A topographical map should be marked sufficiently clear to locate the position of the plant within one-sixteenth of an inch. This permits accurate location and the determination of the stream that the effluent finally reaches. One application should be filed with each project; this must be signed by the owner or an official, or by the engineer if a letter of authorization accompanies the application.

Factors in Design

Percolation Rates in Soil.—Bulletin 1 shows tables and curves on percolation rates; these curves should be used as the basis for design. They are based on systems that had failed or were about to fail after 20 years of successful operation; therefore systems designed on this basis should operate successfully, if properly maintained, for 15 or 20 years. See PUBLIC WORKS, April, 1938, page 70.

Septic Tanks.—Minimum size permitted is 300 gals. Septic tanks should be designed for one day's detention up to 1500 gals.; and one-half day's detention for flows over 4,000 gals. The chart above covers intermediate flows. Pipe inlets should be 3 ins. above the flow line of the tank; a baffle or a down-branching T is satisfactory. Outlet should also have a baffle or a T extending approximately to middepth for small tanks; for larger tanks a baffle is recommended; and for tanks of more than 3,000 gallons a weir outlet and baffle. One manhole should be provided for small tanks up to 8 ft. long; a manhole at either end for tanks over 10 ft. long. Manhole tops should extend to ground surface; if this is not possible a cover of not more than 12 ins. is permitted, but the location must be referenced. Metal septic tanks made by a reputable manufacturer are satisfactory.

Grease Traps or Separators.—These are not required for single families. For other installations, capacity should be about 2½ gallons per person. Effluent should discharge into a separate cesspool or into the septic tank. The inlet should be of the same type as the septic tank; the outlet should be an extended T with the bottom 3 to 6 ins. off the trap bottom. Some types of commercial grease separators are approved.

Cesspools.—The effective percolation area is the area at the bottom inside the walls and the ground area outside the walls. Allow 12 ins. width of wall for dry stone; effective depth is from invert of the inlet to the bottom. Space cesspools 20 ft. out to out of walls. Ground area required is based on percolation tests shown in Bulletin 1. When located in fine sandy soils, gravel or crushed stone 12 ins. thick should surround the outside of the walls to prevent soil from entering the cesspool.

Tile Disposal Fields.—In porous soils, the effluent from tile lines percolates downward with little lateral spread, but in tight soils there is lateral as well as downward flow. On the most porous soils, trenches 12 ins. wide are desirable, but on large installations

a width of 24 ins. is permissible. With intermediate soils (1.0 to 2.4 gals. per sq. ft. per day) trenches may be 24 ins. wide; for tight soils (0.6 to 1.0 gal. per sq. ft. per day), trenches may be 3 ft. wide, and if 8 ins. of gravel is placed below the tile, a total percolation area of 4 sq. ft. per ft. of trench is allowed.

Other Details.—Tile laterals must be spaced at least 3 times the width of the trench or not less than 4 ft. on centers. Tile distributors should have a minimum diameter of 4 ins. Laterals should not be more than 75 ft. long except in very large installations, where 100 ft. may be used. Where no dosing tank is provided laterals should slope 0.5%; main header should slope 1%. Where a dosing tank is provided, laterals should slope 0.3% and main headers 0.5%. The tile invert should be from 18 ins. to 24 ins. below the ground surface, but a depth of 3 ft. is permissible.

The dosing tank should have a capacity of 75% of the capacity of the tile lines. A single dosing tank should be provided for fields having a total length of tile of 500 ft. or more; alternating siphons and twin tile fields are necessary if the length of tile field is more than 1000 ft.

Data on Volumes of Flow

Wherever possible, actual water consumption data should be obtained and used in determining the bases of design. Organic load is also an important factor. For camps, sewage flows range generally from 25 to 40 gals. per person per day. Lowest figures are satisfactory for tourist camps occupied only at night or for primitive type camps, as Boy Scout "wigwam" camp. Higher figures should be used for better equipped all-day camps, and the design should provide for flows up to 75 or 100 gals. per cap. per day. For hotels, 75 to 100 gallons, 2 persons to the room. For rooming and boarding houses, 3 persons per room, 50 gallons per person. For restaurants, 7 to 10 gals. per person served, which will include toilet wastes. For kitchen wastes, at all-day camps and hotels serving three meals a day, 7 to 10 gallons.

Where the different types of wastes are separated, the division of sewage flow should be about as follows: With 40 to 50 gallons per person total flow, allow 7 to 10 gallons for kitchen wastes, 15 to 20 gallons for toilet wastes and 18 to 20 gallons for showers, lavatories, etc., not including laundries.

Such disposal works should be located at a lower elevation than wells or springs and not closer than 50 ft. from them; but where the soil is porous, the minimum distance should be 200 ft. All sewers within 50 ft. of wells should be of cast iron with leaded joints or of transite; if it is necessary to locate a sewer on a slope above a well, cast iron or transite pipe should be used and the sewer kept at least 100 ft. distant. No sewer should be closer than 25 ft. from a well. All leaching systems should be at least 2 ft. above ground water.

Cost of Operating Automobiles

Based on the operation of 415 automobiles, most of them light cars, which were operated an average distance during 1938 of 10,946 miles each, the American Water Works and Electric Co., Inc., reports that the average cost per mile for operation was 3½ cents. This cost included repairs, gasoline, oil, tires, license plates and insurance, but did not include any allowance for depreciation. Per customer served, an average of 7 miles of travel was required during the year.

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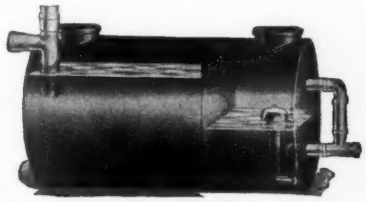
Improved in Design and Operation



For parks, camp sites or other larger plumbing installations outside the sewer areas, specify the San-Equip Septic Tank with built-in siphon unit. Installation features which include improved intake design make this system more practical than higher-cost, individually-built tanks.

Automatic flushing siphon built into tank distributes effluent throughout filter bed. Rest periods permit cleansing of field and increase drainage efficiency.

New Safety and Dependabilty for Homes

San-Equip Master Septic Tanks are of an improved design for camps and homes outside the sewered areas. The operating efficiency of this type tank has long been recognized by sanitation engineers. Exclusive features include improved top intake, longer flow and easier installation. Thorough digestion of sewage is obtained and effluent discharged into drainage field for final purification.

Safe Septic Drainage

The San-Equip Drain Pool is a correctly designed seepage pool that furnishes the most satisfactory and economical septic drainage under favorable soil conditions. Provides drainage in limited area where tile drainage field is impossible. Drainage is kept near the surface of the ground where soil conditions are best for final disposal. Lowers installation cost.

Write for detailed information and recommendations on any sewage disposal problem

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504 E. Glen Ave. Syracuse, N. Y.

Bio-Filters, Aero-Filters and Other

Principles, design details and results of operation of high-capacity filters. Also specifications for underdrainage blocks and for stone

THE general term—high rate filter—that is applied to this type of unit is perhaps a misnomer. It is true that, in general, from 4 to 10 times as much sewage or even more, is applied per unit of volume or of area, but this is not the whole story. Perhaps the term "high capacity" filter would be better since not only is a greater volume of waste treated, but a greater organic load is also handled.

There are, at present, two principal types of these filters. These are: The Bio-filter, developed by Harry N. Jenks of California, and handled by the Dorr Co. and the Link-Belt Co. This process may employ a shallow filter bed, normally about 3 feet deep, and utilizes recirculation of the filter effluent to vary the degree of treat-

The Halvorsen filter was developed by Halvorsen and Smith and is handled principally by the Lakeside Engineering Corp. under the name Aero-Filter. In this method principal reliance is placed on an absolutely uniform and continuous application of sewage to a filter bed about 8 feet deep; in some cases forced ventilation is employed; and occasionally recirculation, especially with stronger sewages and at times of very low flows.

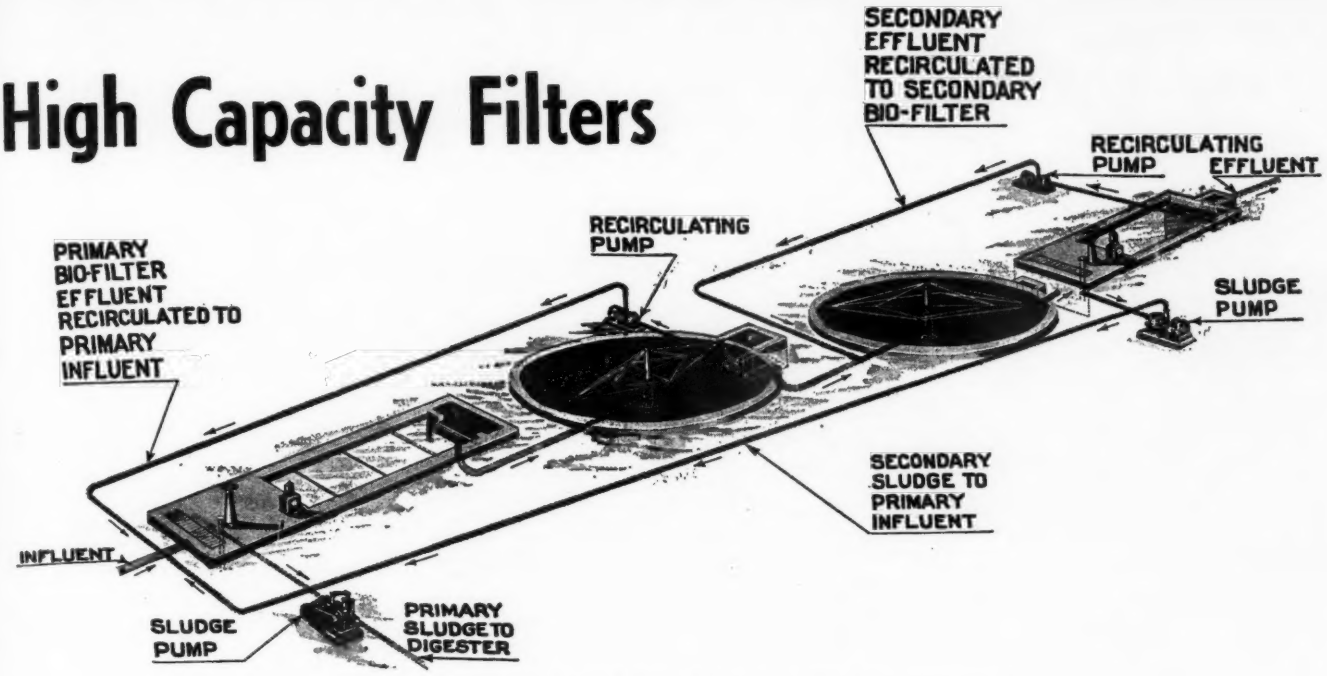
The advantages claimed for these general type of high capacity filters include: A lower initial cost, since a much smaller filter and less broken stone are needed. Some of the objectionable features of trickling filters, as filter flies, freezing, odors, ponding of the surface are practically eliminated. A better effluent is produced than is generally possible with standard rate filters, and in many cases results as good as with any other method of treatment can be obtained. The operating cost is low, as little power is required in operation. The treatment process is not materially affected by fluctuations in the strength of the raw sewage or by industrial waste discharges within reason.

The Bio-Filter

Method of Operation. — For complete treatment, two filters are provided—a primary and a secondary. The sewage after being given primary settling is diluted with about twice its volume of effluent from the primary filter in the case of normal strength sewage, and applied to the primary filter. The effluent from the primary filter is passed to a small sump, where a pump returns a portion to the primary settling tank, thus diluting the raw sewage.

Dorr 0.5 Mgd. bio-filter plant at Covina, Calif. Clarifier distributor and clariflocculator shown—one half of the plant.

High Capacity Filters



Schematic arrangement by Link-Belt of two-stage bio-filter arrangement

A clearer picture of the first stage treatment may be gained from the following illustration. Assuming a flow of 1 mgd, a return flow is built up from the primary filter effluent until 2 mgd is being returned to the influent of the primary tanks, with the flow through them now totaling 3 mgd. This 3 mgd is applied to the primary filter; of the effluent 2 mgd are returned to the primary settling tanks, and 1 mgd is passed on for application to the secondary filter.

The application to the secondary filter is built up in the same way to 3 mgd. On the basis of the example given this 3 mgd flow consists of 1 mgd from the primary filter effluent, plus 2 mgd from the overflow of the secondary settling tank. This 3 mgd effluent from the secondary filter passes to the secondary settling tank; 2 mgd are returned to the recirculation pump for application to the secondary filter, and 1 mgd—equalling the original flow—is discharged from the plant.

A number of variations in this procedure can be made to give more or fewer recirculations—this usually depending upon the strength of the sewage and the degree of treatment desired. The sketches herewith show some of these.

As a rule, this type of plant shows the greatest reduction and is most efficient on strong sewages. Normally an effluent having less than 20 to 30 p.p.m. of B.O.D. and suspended solids is produced. With a weak sewage of 100 p.p.m. B.O.D., the consequent reduction is only 80%; but with a sewage of 500 p.p.m. B.O.D. a reduction to 30 p.p.m. shows a reduction of 94%.

Preliminary Treatment.—Settling is, as in all trickling filters, the preliminary treatment. In the bio-filter, since recirculation increases the flow materially, the primary tanks will generally be larger. This has advantages, since unusually long detention at very low flows and opportunities for septic action are eliminated. Bringing back the stabilized effluent is advantageous. Few states, as yet, have regulations governing detention period. It is believed that 1½ to 2 hours detention should be provided. For a 1 mgd plant, with a recirculation of 2 mgd, the primary tank design should be based on a flow of 3 mgd.

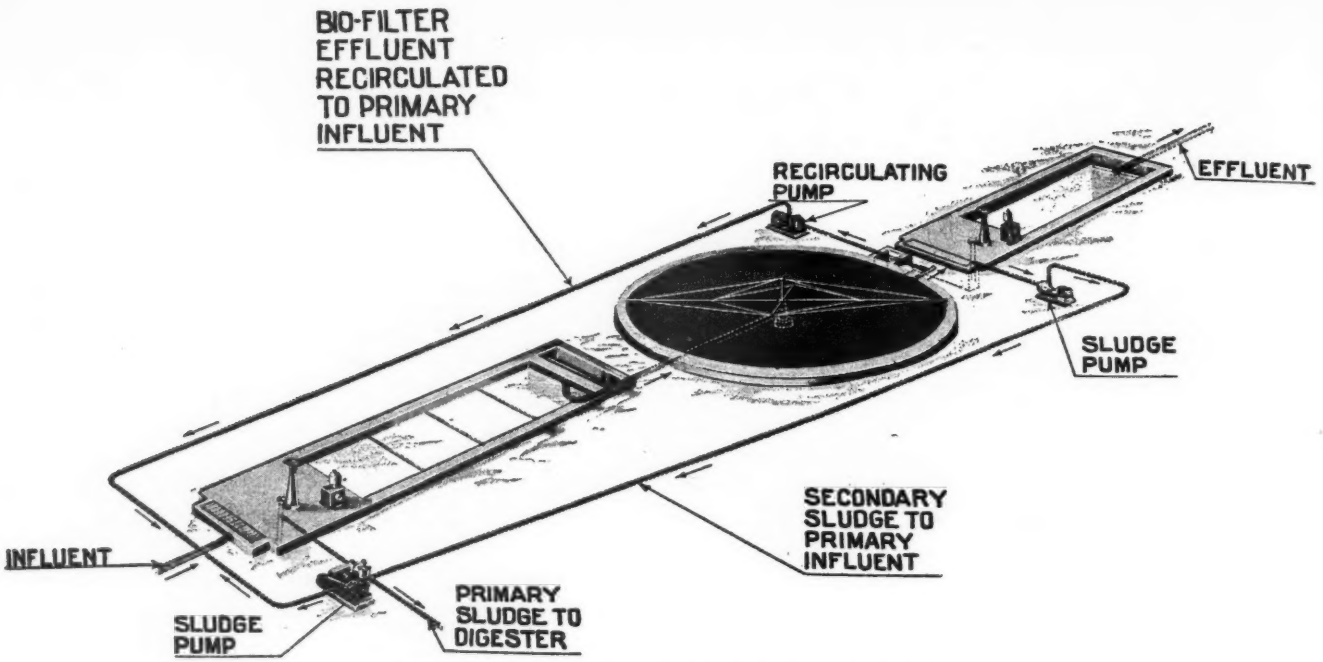
The secondary sludge is normally also returned to the influent of the primary tanks and allowed to settle with the raw sludge. There have been tendencies to feel that this flocculent material aids in sedimentation, but no data are at hand to prove this. The probable volume of sludge is uncertain as data are lacking to give reliable indications of amounts. It appears that sludge production, based on solids contents, will be somewhat greater than from standard-rate trickling filters.

Design of Filter Unit.—The B.O.D. of the raw sewage is the basis for designing the filter units, and this is computed at the rate of 2 to 3, or even slightly over 3, pounds per cubic yard of stone per day. Assuming a flow of 1 mgd, with a B.O.D. of 40 p.p.m., pounds of B.O.D amounts to 8 1/3 x 400 = 3333 pounds. Allowing 3 pounds of B.O.D. per cubic yard of stone, there would be required 1111 cubic yards of filter media. With a bed 3 feet deep, a filter area of about 10,000 sq. ft. would be required. This would be equivalent to two 80-ft. diameter units—a primary filter and a secondary filter.

The primary filter, as a rule, is constructed of coarser filter stone than the secondary filter; 2 to 2½-inch stone is normally used in the primary filter and 1½ to 2-inch in the secondary filter. Aside from this, there is no difference in the design or construction of the two units.

The distributors used must be of a special type, designed to handle the considerable volume of flow to be applied. On the basis of 3 mgd applied to an 80-ft. diameter filter having an area of 5026 sq. ft., the rate of average application is 2100 gallons per minute, or about 600 gals. per sq. ft. per day, as compared to about 50 gals. per sq. ft. per day for the standard filter. On the acre foot basis. the rate of application is about 8.7 mgd and on the area basis, about 26 million gallons per acre of filter area per day. These are astoundingly higher than the rates used on standard filters.

Because of this high rate of application of sewage the underdrainage system, floor and center channel must be designed carefully. Experience is still insufficient to provide exact information on ventilation requirements, but designers have been careful to provide ample openings in the floor system to permit access of air to all parts of the filter media. The area of these openings should aggregate at least 20% of the floor area.



Schematic arrangement by Link-Belt of single stage bio-filter

The underdrains should also provide ample capacity to carry off the flow of sewage, while having also sufficient extra conduit space to permit air to flow freely through them to the opening in the top.

Recirculation Units.—The incoming raw sewage, to which has been added about twice its volume of partly treated sewage which already has passed through the primary filter, is applied to the primary filter. Some of the earlier plants diverted the flow by means of proportional weirs. Recirculation in proportion to the incoming flow results in a large variation in the flow—actually tripling the amount of variation—and made difficult the provision of pumps efficient under such wide ranges of flows. For instance, with a raw sewage flow varying from 500,000 to 1,100,000 gpd—not an unusual variation even during a 24-hour period, and a proportion recirculation on a basis of 2:1, the recirculated flow would vary between 1.5 and 3.3 mgd.

Large sumps and start and stop operation of pumps are undesirable, and any device to control the discharge of the pump within such wide limits is inefficient.

In a recent eastern design, as in other installations constructed to date, a constant amount is recirculated. With an average flow for design of 1 mgd, a pump was selected to return 2 mgd at all times to the primary inlet. With the low flows, at which time the volume of flow in the diluting stream is also normally low, the rate of recirculation is greater than 2 to 1, and a higher degree of purification is effected which is desirable. At times of very high sewage flow, the diluting stream is larger, and the lower resulting recirculation ratio is unimportant.

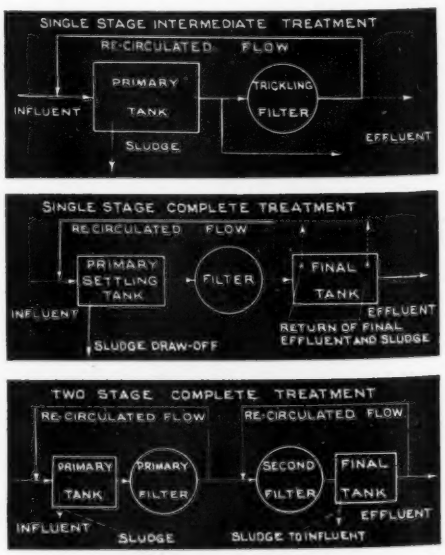
With this arrangement, excessive variations in flow are reduced. With raw sewage flows varying between 0.5 mgd and 1.1 mgd, the flow plus recirculation varies by only the same difference, being 2.5 mgd minimum and 3.1 mgd maximum. In addition to providing a higher degree of treatment during dry periods, and to reducing flood flows—a very important element—this method permits the selection of an efficient pump and its operation at the most efficient rate.

Flood Flows.—High sewage flows usually occur in most sewer systems during storms or rainy periods even when every effort is made to exclude storm water. With a large recirculation ratio very high flows may occur through the plant necessitating special considerations in design to handle such flows; or the recirculation pumps may be cut out of service automatically when the flow reaches a certain volume. If flood flows are high, cutting out of the pumps is usually best.

As an instance of this problem, in a recent design it was considered that a maximum flood rate of 2.8 mgd might be attained despite the fact that every effort has been made to exclude storm water. With a recirculation flow of 2.0 mgd, a total flow of 4.8 mgd might result. It was considered undesirable to design the filter for such a large flow. While extra head would have been required in the channel design, which could be ill-spared, the primary reason lay in design of the siphon. Since the plant can, and probably will at times be operated as a straight trickling filter plant, it would have been necessary to design the siphon to handle flows varying from about 20,000 gallons per hour for early winter mornings, to as much as 200,000 gallons per hour. To accommodate such a 10:1 ratio is difficult.

Therefore in this particular plant, the pumps are automatically cut out at a predetermined flow and remain out of operation until restarted by hand. The reason for manual restarting lies in the fact that, with the very small sumps used, there would be a period of on-and-off operation, during a part of which time the on-and-off periods would be very short.

Distribution.—If the bio-filter is to be operated both as a high capacity



Flow diagrams of bio-filter

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Width: 12″ Vertical Height of Tuyeres 2¾″ Coverage: 216 sq. in.
Length: 18″ Width of Tuyeres: 1″ Weight: 34 lbs.
Height: 6″ Effluent Channels: each diameter 3½″; depth 3″ Area inflow openings: 52 sq. in.

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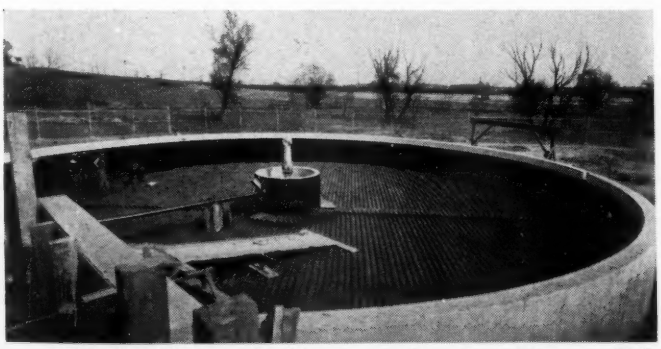

AERODRANE installed in a round tank at Elsmere, Del.

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filter and as a standard rate filter, a special distributor is used, the arms being so arranged that when used as a standard rate filter only a portion of the arms are in operation.

Final or Post Treatment.—The bio-filter effluent contains suspended matter at all times, and this is mainly both light and fine so that it does not settle quickly. Consequently long settling periods are desirable; coupled with the fact that recirculation increases markedly the volume of effluent, this requires that the tanks for final settlement be large.

A detention period of 1½ hours is recommended for these final settling tanks. With a flow of 1 mgd and a recirculation of 2 mgd, the final tank should provide 1½ hours detention for 3 mgd. Overflow rate is important also; probably it should not exceed 1000 gallons per sq. ft., per 24 hours.

Results of Operation

Results of operation on a number of bio-filter plants in California are available, mainly in the form of test runs made by the Dorr Co. The Petaluma plant, with two stage operation, gave the following results: Raw sewage B.O.D., average for five tests, 580 p.p.m.; secondary clarifier effluent average of five tests 34.6 p.p.m. In one of the tests, where a high total dosing rate was used—42.1 mgd—the B.O.D. of the effluent after final setling was 68 p.p.m. Excluding this test, the average effluent B.O.D. was 26 p.p.m., which appears to be about representative. For the same four tests, suspended solids in the effluent were 50 p.p.m., as compared to 429 p.p.m. in the raw sewage.

Two tests on the Healdsburg plant showed raw sewage B.O.D. average at 350 p.p.m. and final effluent at 26 p.p.m.; raw suspended solids at 225 p.p.m.; and final effluent at 28 p.p.m.

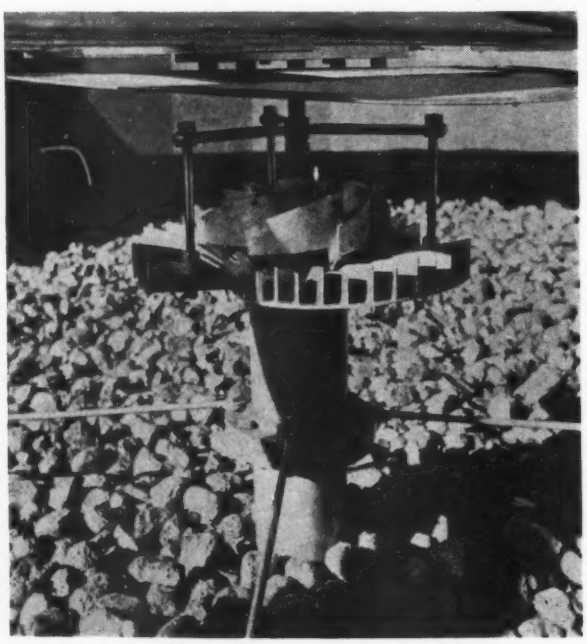
Four tests at San Mateo with raw sewage B.O.D. averaging 226 p.p.m., showed effluent B.O.D. of 18 p.p.m.; raw suspended solids were 222 p.p.m., and effluent 25 p.p.m. These results seem quite representative for two stage treatment. With single stage treatment, using a single filter, results are about as with standard rate filters.

Cost of Operation. — The cost of operation is usually less than that of a trickling filter by reason of the lesser interest and amortization on the lower first cost, but cost of operating the recirculation pumps is an added item. The relative importance of pumping costs depends largely on the power rate. Under most conditions, the costs of operation will be lower than with standard trickling filters.

The Aero-Filter

Rate and Method of Application to Filter. — The operating efficiency of the Aero-filter is based upon improved momentary distribution of the sewage over that heretofore accomplished on other types of trickling filters and not on large percentages of recirculation. Ideal distribution would be effected if every square foot of filter surface momentarily and continuously received exactly the quantity of sewage as every other equal area of filter surface. In other words, the actual rate per second of sewage application to the filter at the point of contact is considerably less than employed on usual types of trickling filters. The result is a slow trickling of the sewage over and down through the media in a very thin film which provides a maximum period of contact and of aeration.

Basis of Design.—The filters are designed on the basis of a total flow per day of not to exceed a rate of 18



DISC DISTRIBUTOR

THE AERO-FILTER

LOW INITIAL and LOW OPERATING COSTS

Aero-Filters can be installed for approximately 60% of the cost of standard filters, and operating costs are lower than for other methods giving the same degree of purification.

HIGH CAPACITY-RAINDROP APPLICATION

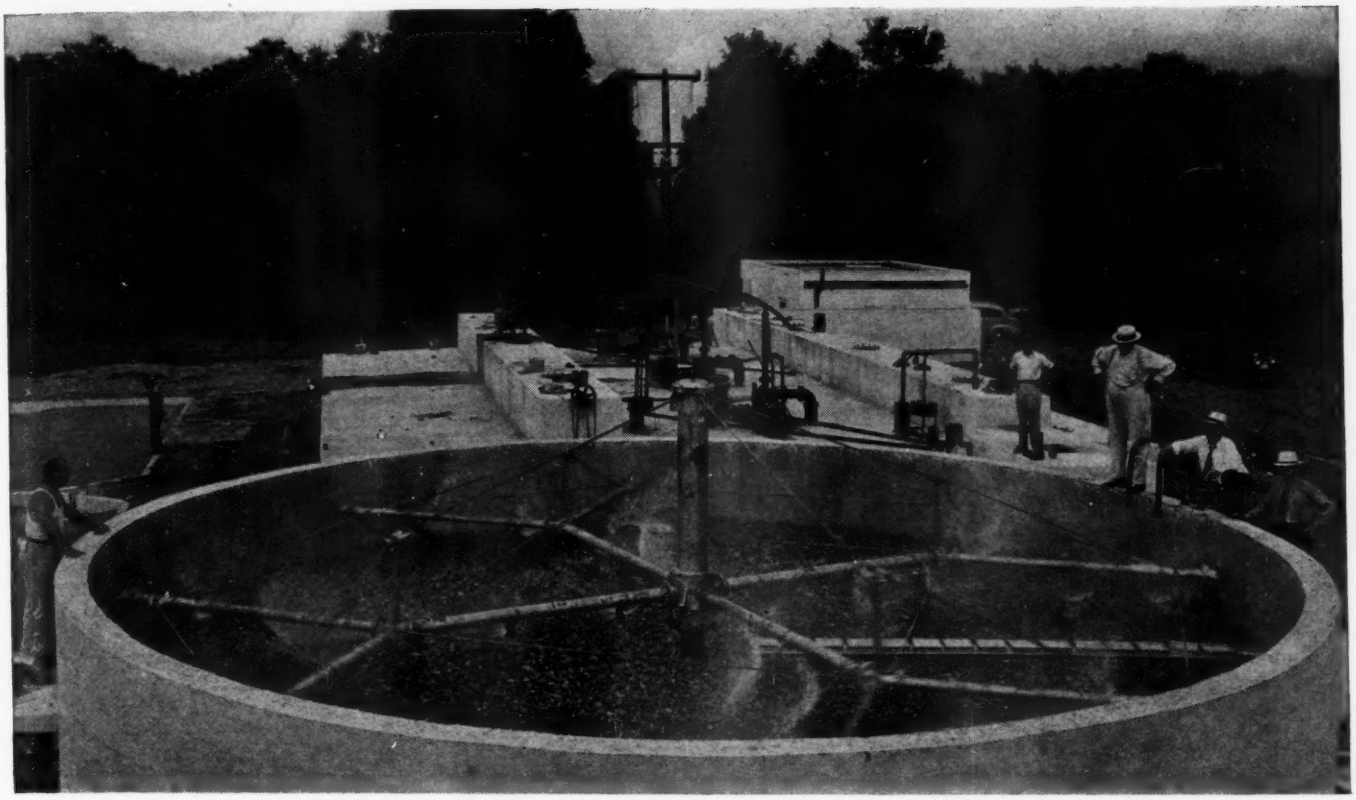
Lakeside *Disc* and *Rotary Distributors* were designed to produce the conditions required for the Halvorson-Smith Process—a continuous rain-like spray, uniform over the entire filter bed, resulting in a low rate of application, larger daily capacities and a high degree of purification.

Send for Bulletin 108 giving complete information on design.

LAKESIDE ENGINEERING CORPORATION

222 WEST ADAMS ST., CHICAGO, ILLINOIS

SEWAGE PURIFICATION, WATER SOFTENING AND CONDITIONING



The 34-ft. aero-filter at a Houston, Tex., suburb: operation results on page 68

mgad and a maximum flow per minute at a rate of 26 mgad. However, the rate per minute may be increased for short periods during the day or during storm flows without affecting results. The B.O.D. loading is an important factor in determining the size of the filter.

On the basis of the raw sewage B.O.D., the total daily loading on the filter is figured at a maximum of 3.5 pounds per cubic yard of rock, or 2,278 pounds of B.O.D, per cubic yard of rock, actually applied to the filter surface, assuming that 35% of the raw sewage B.O.D. is removed in the primary clarifier. In general it is recommended that the B.O.D. applied to the surface of a single stage filter be figured at not more than .75 pounds per square foot of filter area and that in two-stage operation the B.O.D. applied to the surface of the first-stage filter should be figured at 1 pound per square foot of area. These figures may be increased for very heavy sewages or where high degrees of purification are not required.

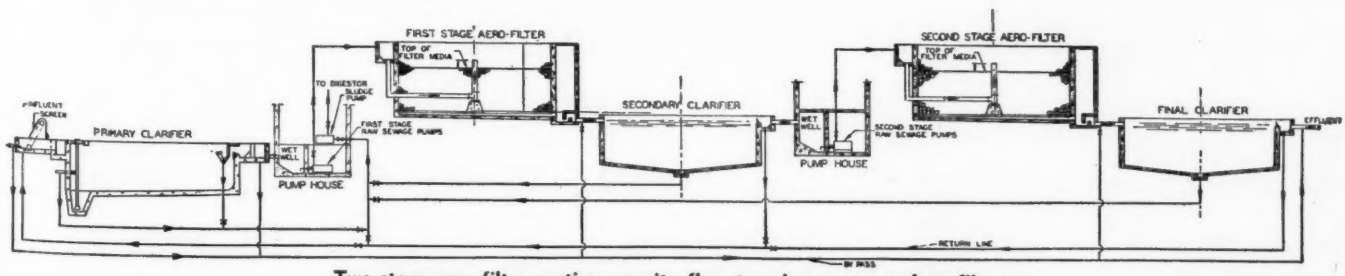
Filter Bed Depths.—Most of the Aero-filter installations have bed depths of from 6 ft. to 8 ft. but beds as shallow as 3 ft. may be used if the areas are increased to provide the necessary quantity of filtering media on the bases of design already stated.

Filter Media Sizes.—In single-stage operation the filter media ranges from 2″ to 4″ in diameter, whereas in two-stage operation the size of the media in the second stage is reduced to 1½″ x 3″.

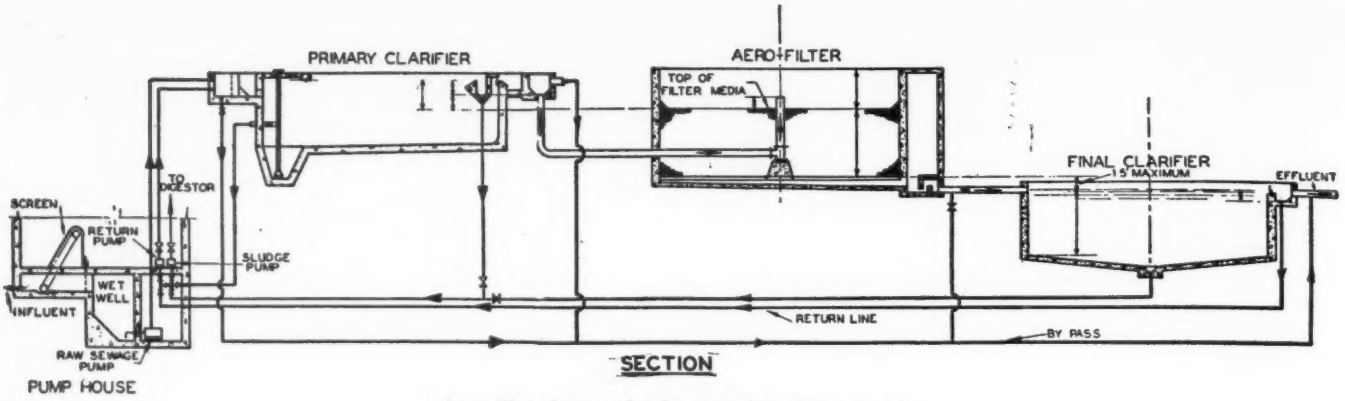
Ventilation. — Artificial ventilation is recommended during those periods when the temperature of the sewage and the air are within a range of 10° F. of each other. Therefore ventilating fans should be installed. These fans pull air down through the filter, at the rate of one cubic foot per square foot of filter area per minute. The sizes of the required fans are very small in practice and their cost of operation is almost negligible. The underdrain system should be designed to provide plenty of air capacity and should be of such capacity that the channels will never flow more than half full.

Distributors and Distribution. — Multiple arm rotary distributors may be used on all sizes of Aero-filters. The Lakeside Engineering Corporation recommend centrally located disc distributors for filters 34′ in diameter and smaller, and rotary arm distributors for larger filters. In order to keep the rate of application on each square foot of filter surface at a minimum it is desirable to make use of as much of the surface momentarily and continuously as possible.

The Lakeside motor driven centrally located disc, which sets approximately 20″ above the top of the filter surface, applies sewage in a rainlike form to all sections of the filter surface con-



Two-stage areo-filter section: gravity flow to primary; pumped to filters



Aero filter layout, showing pumping of raw sewage

tinuously and is well adapted to the needs of the Aero-filter distribution.

When rotary arm distributors are used the center of the arms are placed from 12″ to 15″ above the top of the filter rock in order to provide a maximum of oxygen to the sewage before it contacts the filter. The maximum hydraulic operating head on the center of the arms is about 3 feet for maximum flows in order to provide sufficient head properly to discharge the sewage in a rainlike effect from the centrifugal nozzles at minimum flows. It is desirable to apply sewage to any given radius of the filter at least once every three seconds and the Lakeside distributor is designed to give a momentary application in a rainlike form to at least 20% of the filter surface. Distributors may have 6 to 10 arms to insure the desired application.

The centrifugal nozzles and the method by which they are attached to the arms of the Lakeside distributor make it possible to adjust the distribution very accurately in the field. Moreover, the nozzles can be so set that the distributor can be made to maintain the same speed of rotation at maximum flow as at the minimum flow. The sped of rotation is usually held at about 500 lineal feet per minute at the ends of the arms regardless of the size of the distributor.

Recirculation.—Recirculation of the sewage from the final clarifier back to the front of the plant, or to the primary tank, may be made in any quantity desired. However, tests have demonstrated that highly satisfactory results are produced by recirculation only during periods of low flow and in sufficient amount to keep the filter operating at a minimum rate of from 10 to 13 mgad. By recirculating from the final clarifier back to the front of the plant a complete control of the detention time in all of the plant units is maintained. This assists greatly in reducing, or entirely eliminating, odors which might otherwise result from excessive detention periods. Recirculation is automatic on all units.

Primary Settling Tanks.—It is recommended that primary settling tanks be designed so that the maximum overflow rate per square foot of surface area shall be not in excess of 1000 gallons in 24 hours with a minimum detention period of 1½ hours.

Secondary Settling Tanks.—When two stage operation is used it is necessary to provide an intermediate or secondary settling tank. The size of this tank may be designed by using two-thirds the area and capacity recommended for the primary clarifier or settling tank.

Final Clarifier.—The sludge which continually sloughs from the Aero-filter is quite fine and if results are to be produced it is very necessary to have the final settling tank at least equal in size to that recommended under Primary Settling Tanks.

Results.—According to the Lakeside Engineering Corporation, Aero-filters have shown that they will normally give overall reductions in B.O.D. through the plant ranging from 82% to 92% for single-stage operation and from 88% to 98% for two-stage operation.

Where reductions in B.O.D. commensurate with standard filter operation are desired, single-stage operation is recommended, provided the raw sewage B.O.D. is not in excess of 400 to 450 p.p.m. Where a higher degree of purification is desired for such a sewage, or where heavier sewage is to be handled, two-stage operation is recommended.

Single-stage Aero-filters on normal domestic sewage, either with or without rather large quantities of creamery waste, are producing average overall B.O.D. reductions through the plant of about 88% to 90% with some plants running as high at 93 to 94%.

The following results were obtained from the Texas State Board of Health.

Results of Operation

1939

	3/7	3/16
Dissolved Oxygen Ppm.		
Raw Sewage	2.4	3.4
Effluent	4.6	7.0
5-Day B.O.D. Ppm.		
Raw	145	114
Effluent	21	20
Reduction	85.6%	82.5%
Settleable Solids Ppm.		
Raw	235	144
Effluent	24	4
Reduction	89.6%	97.0%

These tests were made by the regular field forces of the State Board of Health on the aero-filter at West University Place, Texas, a suburb of Houston. The Aero-filter is 34 ft. in diameter with 8 ft. rock depth. Operation began Sept. 5th, 1938. The plant

THIS IS THE THIRD IN A SERIES OF ARTICLES ON

Trickling Filter Design Construction and Operation

•

1—Design Factors and Loadings (February)

2—Underdrainage and Ventilation (March)

•

The next installment which will appear in May will cover:

Distributors

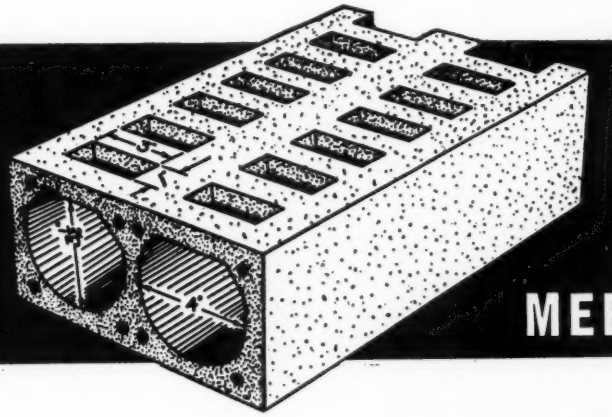
Siphons

Spray Nozzles

Operation

A Trickling Filter Is As Efficient As Its Underdrain System

How "ARMCRE" FILTER BOTTOM BLOCKS MEET THE REQUIREMENTS



Hundreds of Installations!

"ARMCRE" Filter Bottom Blocks have been installed in hundreds of Sewage Treatment plants and below are some of the reasons the engineers specified it:

When you buy Armcre Filter Bottom Blocks you buy a complete floor as the following fittings are kept in stock at all times: one-quarter, one-half and three-quarter length blocks; fifteen, thirty and forty-five degree angle cuts; cover blocks for covering drainage channels and cover blocks with holes for aeration feature at edge of beds; also reducers which solve the double problem of making the underdrain system accessible for quick inspection, flushing or cleaning without weakening the masonry wall, as shown on our detail sheet.

The Design assures adequate air supply, the area of the ducts is 25 square inches per block, 50% of its cross section! Each block has 14 openings, aggregating 42 square inches, allowing air to circulate freely and maintain aerobic condition.

Armcre blocks are made of the best deaired Vitrified shale and fire clay ware. They are smooth on the entire inner surfaces of the ducts, and solids by adhesion or absorption do not accumulate.

Exact alignment and grade are made easy by the longitudinal center line scored on each block so they can be laid in an exact vertical plane along its entire axis.

Write and we will be glad to send you a list of installations including the names of the designing engineers and a detailed description of "Armcre" Filter Blocks.

THE BOWERSTON SHALE CO., Bowerston, Ohio
AYER-McCAREL-REAGAN CLAY CO., Brazil, Indiana
LICENSED MANUFACTURERS

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 80-83.

was designed for a total daily load of 417,000 gallons (20 MGAD) domestic sewage, and for a peak rate of 435 GPM (30 MGAD). All results are based on 24-hour composite samples, and are parts per million.

Some notes on operating and plant conditions were supplied by L. E. Livingston, as follows: The plant is heavily overloaded, at times, due to the rapid growth of the community and heavy infiltration. This is a high-grade residential section of Houston and is growing rapidly; some 600 homes have been built during the last year. Through the day the flow seldom drops below 400 GPM and for several hours it reaches 500 to 650 GPM. The final settling tank is non-mechanized and there is considerable short circuiting.

The Lakeside rotary distributor is equipped with four arms which extend half-way across the radius of the filter. On the end of each arm is a "Y," the arms of which extend to the filter periphery. At flows in excess of 400 GPM the rotary turns at 5 R.P.M. No recirculation is made except during the last half of the night to maintain the minimum required rate to the filter. Minnows are living in the final settling tank. I observed the effluent on August 1st, 1939, when the flow was 370 GPM, and found the plant effluent clear as drinking water.

Some 1939 operating results at the Renville, Minn., plant are given below, all results being of composite samples taken during the daytime:

	B.O.D.	
	Raw	*Effluent*
June	600	12.5
	170	20.5
July	340	25.
	240	25.
	200	27.
August	300	25.
	540	50.
	270	12.5
September ..	190	22.
October	180	17.5
	470	27.

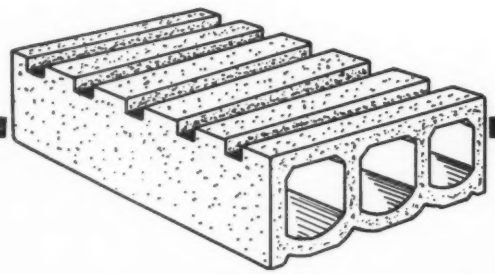
Media for Filters

Broken stone and slag are the materials that have been used principally for filter media in trickling filters. Whatever the material, it should be sound and durable, free from fines, properly graded and resistant to deterioration.

The usual means for determining soundness or durability is the sodium sulphate test, which is applied to about 20 particles of the filter material, these being selected by quartering or other similar means, over a period of 20 days. The freezing and thawing test may be used instead, but requires more equipment and a longer time for completion. When the sodium sulphate test is used, little loss of material should result from the 20 testing cycles, and any media of which 10% of the number of pieces fail, or the total loss of material is 10%, should be considered unsuitable.

The cost and trouble of testing is small considering the value of the knowledge obtained; however, in small installations, it may be sufficient to inspect the source of the stone; if other filters using this stone show satisfactory service, or if the stone has been used successfully in state highway work, it is probably all right for filter use.

Dirt or foreign materials of all kinds, and any materials of small size are objectionable. Washing of the crushed stone is desirable. The usual range of sizes is between 1 and 2½ inches, though many engineers limit the range of size between maximum and minimum to 1 inch, as 1½ to 2½, or 1 to 2 inches. Whatever the sizes specified, a tolerance of not more than 5%, by either volume or weight,



The Efficient Block With the Transverse Slot

The recognized merits of TRANSLOT Filter Block have made it a favorite with Engineers, Contractors and sewage disposal plant operators.

Made of vitrified clay from a thoroughly engineered design it is subject to close manufacturing control so you will be assured of a uniformly high quality block.

Every job is given individual treatment by our engineering department. Let us supply estimates and further information without obligation to you.

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TRANSLOT

CANNELTON SEWER PIPE COMPANY
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should be permitted for material both above and below the sizes specified. Fine material is particularly objectionable, and 3% by weight of the material should be the maximum that is finer than the minimum size specified. If necessary, the stone should be rescreened to insure this.

Every shipment of stone, if by freight cars, should be sampled; if by truck (which is now the most common method of shipment), rigid inspection and frequent sampling are required. Fines tend to collect in the bottom of the truck body, and samples should be taken or inspection should be made at that point. In those cases where appreciable fine materials are found, the stone should not be dumped into the filter direct, as this will result in pockets of fine materials, which may cause pooling or ponding. A bucket or belt conveyor is suitable if the material is deposited in layers not more than 2 feet deep; in deeper layers, the material cones, with the finer at the center. No sound and generally applicable method of placing stone in filters appears to have been developed. Dumping in piles outside the filter wall and placing in the filter with barrows or carts loaded by hand with forks is satisfactory but costly.

Placing of the stone requires considerable care. It is best to place a layer of coarser materials about 6 inches thick directly over the underdrains. This must be placed carefully, so as not to disturb or damage the underdrainage system; it may be necessary to place this by hand methods. The remainder of the stone can then be put into the filter by less exacting and costly means. No matter how much care is used, however, some fine material will enter the drains. This should be removed by flushing or by other means, as by pulling a bag filled with straw through the channels, or by placing strips of burlap or building paper in the channels and pulling these out after the stone is placed.

Specifications for Filter Stone

The following specifications, used at Dallas, Texas, for the filter stone in the sixteen 170-ft. trickling filters now under construction, were furnished us through the courtesy of R. M. Dixon.

The aggregate shall be crushed stone of a quality successfully and satisfactorily to withstand the disintegrating effects of the weather and the sewage applied. The aggregate may be granite, limestone or trap rock, and of such properties, both chemical and physical as to satisfy the following:

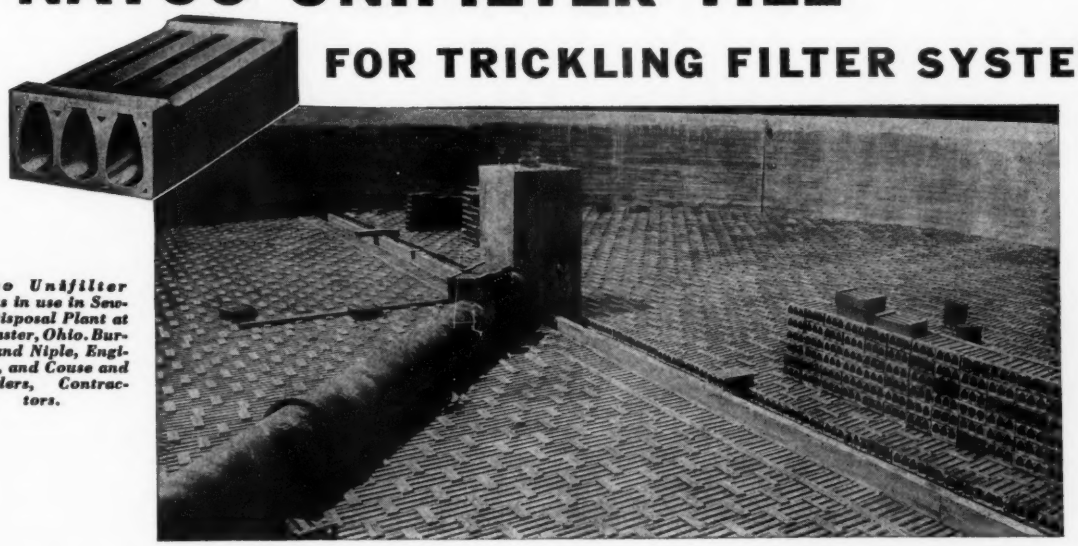
Wear % not more than	3.7
Absorption % not more than	.70
Sp gravity, min.	2.60
Hardness, min.	12.00
Crushing strength, per sq. in.	15000 lb
Calcium carbonate (if limestone) not less than	83.%
Sulphate (SO_4) not over	1.2%
Organic matter	none
Loss, sodium sulphate, 20 cycles not over	10.%
Pyrites	Trace
Shall be of following sizes and/or grades:	
Amount retained on a 3" round screen but passing 3½	0-5%
Passing 3" round screen but retained on 2" not less than	50.%
Passing 1½" round screen	0-5.0%
Passing 1" round screen not more	3%

Soil and clay will not be permitted in the stone and hand picking may be required to prevent the presence of such in the finished product when quarrying operations touch the soil contact zone.

That the broken or crushed stone shall consist of one operation of the crushing and screening plant and recombining will not be allowed.

NATCO UNIFILTER TILE

FOR TRICKLING FILTER SYSTEMS



Natco Unifilter Blocks in use in Sewage Disposal Plant at Lancaster, Ohio. Burgess and Niple, Engineers, and Couse and Saunders, Contractors.

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Where local materials are not entirely satisfactory, and shipped-in materials are very costly, it may be permissible to use the best material for the top foot of the filter and the less costly and less satisfactory material for the under portion of the bed. This must usually be passed on by the State Board of Health. Usually, it is better to construct the filter properly throughout in the first place, going to some expense to remove fine material, to supply suitable filter media and to place the stone properly. Initial increases in construction costs are less than later costs of replacement or washing, and better results are obtained with a properly constructed filter.

Clay Media For Filters

Various types of filter media have been employed, especially in connection with high rate filters. Among these are the "Raschig rings" which are hollow cylinders of equal length and diameter, and with only enough wall thickness to give the necessary strength. These are rather high in first cost, but tests indicate that the ¾ and 1 inch sizes give a much greater removal of B.O.D. than an equal volume of stone or slag. Another type of clay medium is a clay tile or block about 12 inches cube, which is perforated with the maximum practicable number of 1-inch diameter holes; these blocks being so set, one above the other, that each hole is continuous from top to bottom of the filter. The sewage flows down around the perimeter of each hole, while air comes up through the center of it. Experience with these also indicate a much greater B.O.D. removal than with ordinary filter media.

Tentative Specifications and Tests for Vitrified Clay Filter Block for Trickling Filters

Tentative specifications for vitrified clay underdrainage blocks and for filter stone follow:

(A). *Scope*—1. These specifications are intended to cover one piece filter block of the self spacing type, made from vitrified clay.

(B). *Materials*—2. The term clay shall include fire clay, shale or mixtures of these. These materials or any combination thereof when molded into block and subjected to suitable temperatures shall produce a product that will be strong, durable, serviceable and shall conform to these specifications.

(C). *Classifications*—3. Filter block may be either glazed or unglazed but all filter block shall be well vitrified within the strength and absorption limits of these specifications.

(D). *Shapes*—4. Under these specifications the filter block shall be of rectangular shape or rectangular in plan so as to completely cover the subfloor of the filter bed. When laid adjoining each other the block shall form a continuous system of ducts for the conveyance of liquids from the bed and the passage of air into the bed. Apertures or slots cut in the top of the block shall provide passage between the ducts and the filtering media.

(E). *Apertures*—5. Apertures in the top of the block shall not be more than 1½" wide but may vary in length. The aperture area shall not be less than 20% of the greatest horizontal area of the block when in position of use.

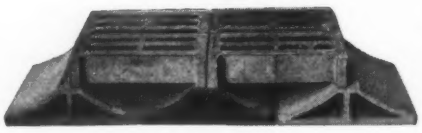
(F). *Dimensional Tolerances*—6. Exterior walls shall not be less than 9/16" thick and interior webs shall not be less than ½" thick. The permissible variations in dimensions shall be as follows: plus or minus ¼" per foot of length, plus or minus ¼" per foot of width, and plus or minus ¼" per foot of height. The bottom bearing surface of the block shall not vary from the horizontal plane by more than ⅛" per foot of greatest length and breadth of the block.

(G). *Workmanship and Finish*—7. All block shall be well burned, substantially free from laminations, fractures, cracks and blisters, within the limits of these specifications.

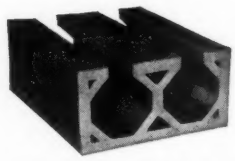
(H). *Marking*—8. All block shall

"METRO"

VITRIFIED FLOOR SYSTEMS FOR TRICKLING FILTERS



Both ("Metro") Trickling Filter Floors are so designed that dust and small stone can be removed readily from the channels when the filter media is being placed.



TWO-PIECE UNIT

The "Metro" Two-Piece Vitrified Floor System for Trickling Filters, has been tested and has proven itself to be superior to anything of its type, both as to results obtained and simplicity of construction. The percentage of open area in the floor is the largest obtainable within safe limits of the load carried.

MONO-UNIT

The "Metro" Mono-Unit Filter Floor was developed to combine as many as possible of the characteristics of the two-piece flooring with a lower installation cost. The Mono-Unit has the maximum free opening for single units now on the market.

Prices Quoted on Application . . . Manufactured by:

THE METROPOLITAN PAVING BRICK COMPANY

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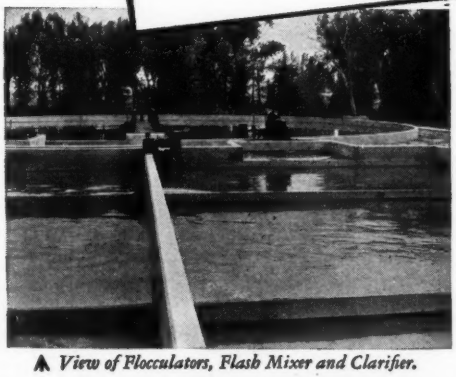
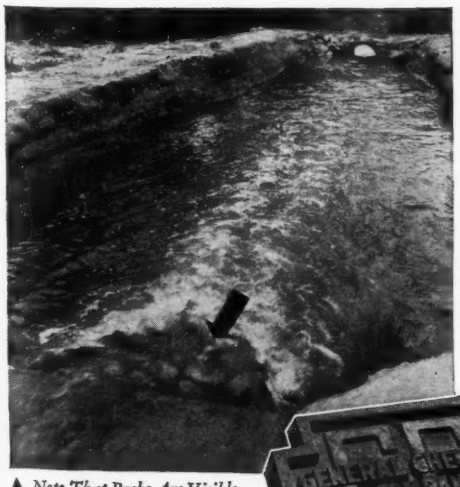
EFFLUENT MUST BE CLEAR

...So Colorado Springs Disposal Plant Uses GENERAL CHEMICAL 'ALUM'



▲ *View of Flocculators, Flash Mixer and Clarifier.*



▲ *Note That Rocks Are Visible Showing Clarity of Effluent*

*Designed by Burton Lowther, Consulting Engineer, Denver.

Clear, pure effluent is required at the Colorado Sewage Disposal Plant* because the effluent flows into a nearby river, the water of which is used during the summer months by farmers for crop irrigation. *For this reason, it is absolutely essential that the effluent be as clean as possible.*

Clarity and purity of effluent at Colorado Springs are accomplished by chemical precipitation using General Chemical Aluminum Sulfate and a small amount of lime for control of pH. Chlorine is used to reduce bacterial load.

General Chemical Aluminum Sulfate is used because:

1. It is simple to apply, clean and easy to handle.
2. Requires only simple, low cost equipment for application.
3. It is a year round coagulant.
4. Does not necessarily require other chemicals to complete the reaction and there is no complicated problem of properly proportioning two or more chemicals.
5. Can produce crystal clear, near zero turbidity effluent.
6. Precipitated sewage sludge digests easily and yields a high gas production.
7. Treated digested sludge dries quickly and without odor.
8. It is preferred and specified by a majority of important American municipalities.

General Chemical Company will be pleased to extend the cooperation of its specialists to Consulting Engineers who are designing sewage disposal plants and to those desiring better results from existing plants. Your inquiries are cordially solicited. Write to

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 80-83.

bear the names, initials or trade mark of the person, company or corporation by whom manufactured.

(I). *Physical Requirements*—9. Filter block shall be capable of standing without fracture an average compressive strength of 600 lbs. per sq. in. in terms of the greatest horizontal area of the block. No individual minimum test shall be less than 500 lbs. per sq. in.

10. The water absorption of the block shall not exceed 6% of the dry weight of the block.

Tests

(J). *Sampling*—11. Samples of block for testing shall be selected at random by the purchaser or by a competent representative authorized by him to do this work and shall be fully representative of the shipment.

12. For the strength and absorption tests 5 individual block may be selected from each 1000 sq. yd. lot and in no case shall less than 3 block be tested.

13. Specimens selected for compressive strength tests shall be full size block or fractional size block to suit available testing equipment but in no case shall block having less than 100 sq. in. gross horizontal sectional area be used. The samples must represent the full width of the block.

14. Trial pieces for absorption tests shall be selected from specimens which have been broken during compressive strength tests. These pieces shall be sound, free from visible cracks, loose fragments, capping materials, and waterproof coatings.

15. All block selected for test shall be plainly and permanently marked for reference by the testing operator.

(K). *Compression Tests*—16. Three or more test specimens which have previously been dried at 212 deg. F. shall be used.

17. The speed of the moving head of the testing machine shall not be more than 0.05 in. per minute.

18. A spherical bearing block of proper design shall be placed on top of the test sample.

19. Bearing surfaces of the test samples and portions adjoining them which are liable to absorb water from the plastic capping shall be coated with shellac and allowed to dry. A quantity of plastic mortar made of a mixture of three parts (by volume) of Portland cement and one part unretarded gypsum (Plaster of Paris) mixed with sufficient water to spread evenly shall be placed on a plane surface which has been coated with oil, and the Mortar allowed to harden sufficiently to bear the weight of the block. The surface to be capped shall be placed on this mortar and while holding the specimen so that its axis is at right angles to the capping surface it shall be given a single firm pressure. The average thickness of the cap after the extruded plaster has been removed and the edges trued shall not be more than 1/8". Patching of caps after setting shall not be permitted. Imperfect caps shall be removed and replaced with new ones.

The cement-gypsum cap shall age at least three days before the block is tested.

20. All block shall be tested in a position such that the load is applied in the same direction as in service.

21. Where the design of the block is irregular it shall be tested in such position as to uniformly load the supporting walls as they would be used in service. Special adapter caps may be used for imposing the load between the heads of the testing machine.

(L). *Absorption Tests*—22. The samples shall consist of at least three sections as described in J-13, or three representative pieces from each of these three block. If small pieces are used, two shall be taken from the shell and one from an interior web, the weight of each piece to be not less than 227 g. (1½ lbs.). The samples shall have their rough edges or loose particles ground off and be free from cracks.

23. Each piece shall be marked so that it may be identified at any time with the block from which it was taken. Marking which do not cover more than 5% of the total superficial area of the piece shall be used.

24. Preparatory to the absorption tests all samples shall be dried to constant weight in a drier or oven at a temperature of not less than 100 deg. C. (212 deg. F.).

25. The balance shall be sensitive to within 0.2 percent of the weight of the smallest unit or piece tested.

26. After obtaining the dry weight of the samples they shall be immersed in soft, distilled or rain water, raised to the boiling point and boiled continuously for one hour and then allowed to cool in water to room temperature.

27. After saturation, the samples shall be removed from the water and allowed to drain for not more than one minute. The superficial water shall be removed with a damp cloth, after which they shall be weighed immediately.

28. The test results shall be calculated as percentages of the initial dry weight, carried to the nearest first decimal place. The results shall be reported separately for each block, with the average for the group.

(M). *Results of Tests*—29. Failure of the specimen to meet the individual requirements of compression or absorption tests shall result in the rejection of block in the shipment or pile from which the block were selected, however, the manufacturer or seller may at his option and expense, cull the lot to remove block typical of the failure and may submit the balance of the shipment for retest.

(N). *Inspection*—30. All block shall be subject to inspection at the factory or job site and shall conform to the requirements herein specified.

31. a. All block shall meet the physical requirements of these specifications.
    b. All block shall comply with the permissible variations in dimensions of these specifications.
    c. All block shall be free from cracks that exceed 2" in length.
    d. All block shall be free from fractures or chips in walls or webs exceeding 2" in length, 1" in width and 3/16" in thickness.
    e. All block shall be free from blisters exceeding 2" in diameter and projecting more than 1/8" above the normal surface.

(O). *Expense of Tests*—32. Except as specified in par. 29 the expense of inspection and testing shall be borne by the municipality or purchaser.

Suggested Specifications for Installing Vitrified Clay Filter Blocks

The filter blocks shall be laid in place on the floor of the trickling filter and in longitudinal rows running at the desired angle to the drainage channels. The blocks in each row shall be laid in true alignment and with the cross joints staggered in each row by starting every other row with a fractional length.

The filter block may be laid either dry but with a thin cement grout subsequently poured between each row to bond the blocks to the floor of the tank or, the blocks may be laid and imbedded in cement grout previously screeded to a level surface to take up any unevenness in the floor.

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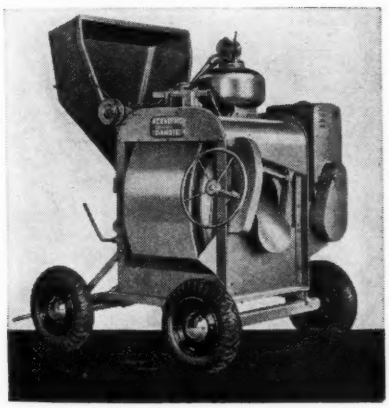
Keeping Up With New Equipment

New Koehring Equipment

Many new design features have been incorporated in the Koehring **10-S** Dandie Mixer. One of the most interesting to the contractor is the rubber-tired drum roller, which reduces drum roller track wear; drum mixing impacts are absorbed.

For the plastering contractor, there is the non-tilting 6-P Kwik-Mix Plaster-Mortar Mixer. An easily opened door discharges the batch directly to mortar box. Weight has been materially reduced and with pneumatic tires, it is easily handled on job. High speed trailing ability is another important advantage. An air-cooled motor transmits the power through the worm drive direct to the mixing blades. A 33" axle can be furnished, permits easy passage through doors.



Koehring "Dandie" Mixer

Two new model Koehring draglines are now available for all types of stripping operations (coal, quarry, etc.) and drainage work with long booms with high "A" frame and up to 3-cubic-yard bucket.

In the dirt-moving field, a new, improved model Koehring Wheeler is now available. With a capacity of 9½ cu. yds., and a high speed pneumatic-tired tractor, this new model moves more dirt faster. Diesel power is available, as well as gasoline. Air is available for tire inflation on the job. Another new model for dirt-moving contractors is the W-60 Dumptor. This unit is equally efficient for hauling dirt or rock. Catalogs on request from Koehring Co., Milwaukee, Wisc.

Koehring "Wheeler"

Type 90 Osgood Shovel

The Osgood Company, Marion, Ohio announces the Type 90, is a heavy duty excavator, available as a shovel, with varying lengths of booms and handles and dippers up to 2½-yard capacity, and with dragline equipment up to 85′ boom and 2-yard bucket, with larger buckets on shorter booms.

This machine is powered by gas, oil, diesel, or electric motor. Power is transmitted from the engine or motor to the countershaft by a fully enclosed Morse silent chain. Power take-off clutch is of disc type. Swing and travel gears are ball bearing mounted, and controlled through wide faced, large diameter contracting band clutches. The crowding and retract unit is self-contained and bolts to the main deck casting.

Full information on request from Osgood Co., Marion, O.

Osgood Type "90" Shovel

New Automatic Sterelator

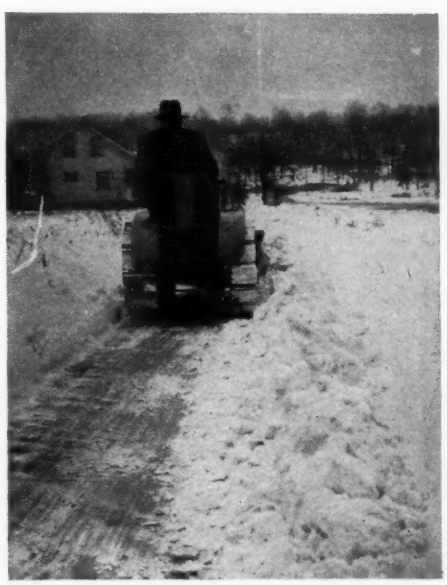
The Everson Mfg. Co., Chicago, Ill., has announced a fully automatic Sterelator, the No. 2700, which automatically proportions the chlorine to the rate of flow and indicates and records the rate of flow of the water or sewage. This and other Sterelators are housed in black crackle enamel steel cabinets with panel openings for access to the working parts.

A Sidewalk Snow Plow

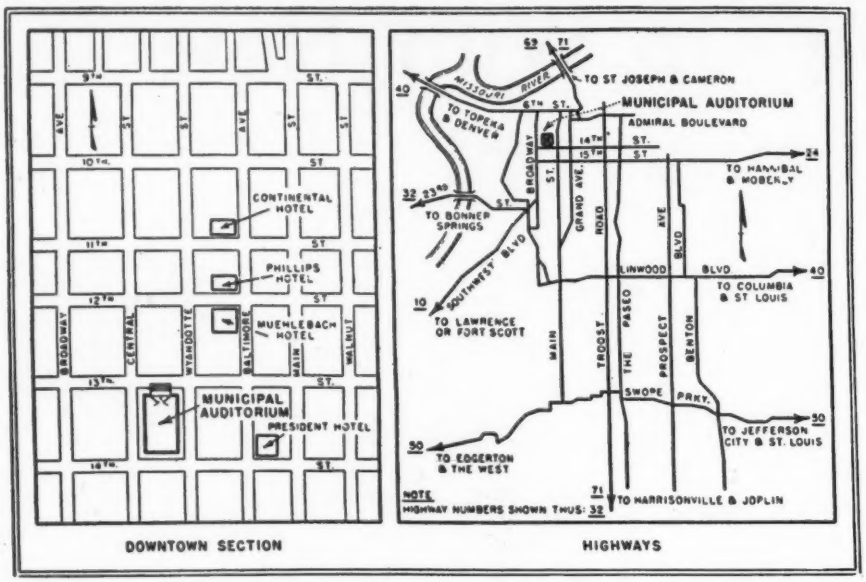
A sidewalk snow plow must be narrow enough to travel along sidewalks, but have enough power back of it to remove even deep snow. There are few municipal services more appreciated by taxpayers than plowing sidewalks, and by keeping school children off the streets it reduces accidents. Cleveland Tractor Co., Cleveland, O., manufacture a small tractor especially designed for this work. It is 42 ins. overall width. It is shown herewith with a Meyer sidewalk snow plow. Full information from Cletrac or from Meyer Products Co., Cleveland, O.

New Aero-filter Bulletin

The new bulletin describing aero-filters, their application and results in sewage treatment is now available. This contains a great deal of information on design and application and is excellently illustrated. There are now some forty municipal sewage plants in fifteen states where filters of this type are in operation or under construction. Some of the information provided in this bulletin has been used in preparing the information on aero-filters which appears on another page of this issue. Sent on request. Lakeside Engrg. Corp., Chicago, Ill.



Cletrac-Meyer Sidewalk snow plow



The AWWA Guide

American Water Works Association

The biggest and best convention of the American Water Works Association is scheduled for Kansas City, Mo., April 22-25. The exhibit will be the largest ever shown, with 147 booths and 3 table spaces, permitting the study of newest equipment, materials and methods in the water works field. A symposium on water works management will be an important feature of the program, which will also include information on the use of steel pipe, a "free for all" discussion on taste and odor control and a round table discussion on wells, pumps and other every-day problems of the waterworks superintendent. Registration opens Sunday afternoon. A special train will leave New York Saturday forenoon for the convention.

There is not space available here for a complete program, but it will be sent on request. Better though to take in the convention and profit by the things you will see and hear there. Public Works Booth number is 107. We shall be glad to see you there.

Pittsburgh Equitable-Merco Nordstrom District Meetings

The final meeting in a series of district gatherings for the salesmen of the Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company was held at the factory in Pittsburgh during the week of February 19th with representatives from the Pittsburgh and Buffalo Sales Offices attending. Starting early in January with a meeting in Tulsa, the Company has, at weekly intervals, held sales meetings in each District Office. Each meeting was conducted by Captain A. E. Higgins, Vice President and Sales Manager. Chief Engineer A. D. MacLean presented the engineering aspects of recently introduced or improved products and open discussions were held under the direction of factory men in order that every salesman would be fully informed. The representatives from the factory in Pittsburgh conserved time by flying from meeting to meeting in the company plane piloted by Captain Higgins.

Permutit at the AWWA Convention

The Permutit exhibit at the AWWA convention will show latest developments in the water works field, including the Spaulding precipitator, pressure and gravity filters with both manual and automatic controls, wet and dry chemical feeders and Zeolite water softeners. In attendance from the main office will be Messrs. Applebaum, Foulds and Saunders; and there will also be a number of field representatives.

PERSONAL NEWS

The following new appointments as city managers have been reported:

Neal D. Smith, Ontario, California.
F. R. Chilton, Pittsburgh, California.
Bruce Brownson, Grand Junction, Colorado.
F. L. Hendrix, Clearwater, Florida.
A. B. Curry, Coral Gables, Florida.
W. T. McIlwain, Fort Pierce, Florida.
A. C. Stubbs, Leesburg, Florida.
G. D. Bogue, Palatka, Florida.
M. N. Yancey, Tallahassee, Florida.
Dean Van Ness, Atchison, Kansas.
Ph. Frankenfeld, Winfield, Kansas.
David Walton, Auburn, Maine.
Charles A. Wild, Jr., Superintendent of Public Works, Teaneck, New Jersey.
G. F. Sheehe, Superintendent of Public Works, Warsaw, New York.
J. L. Caldwell, Chapel Hill, North C.
R. E. Smyre, Hickory, North Carolina.
Don C. Page, Boyertown, Pennsylvania.
Steve Matthews, Borger, Texas.
W. W. Scott, Bryan, Texas.
W. K. Nichols, Commissioner of Public Works, Rutland, Vermont.
B. R. Fuller, Altavista, Virginia.
Asher W. Harman, Bristol, Virginia.
H. H. McCanna, Crewe, Virginia.
Orrin S. Rhudy, Galax, Virginia.
E. P. Mitchell, Bluefield, West Va.
Richard Biehl, Fort Atkinson, Wis.

The following have been appointed City Engineers:

George W. Reese, Arkansas City, Ark.
C. O. Thomas, Hope, Arkansas.
George E. Baker, Long Beach, Calif.
C. R. Sumner, San Gabriel, California.
Edw. K. Hussey, San Leandro, Calif.
Leonard Lenger, San Luis Obispo, Calif.
William F. Nierintz, Torrington, Connecticut.
Charles A. Crum, Cordele, Georgia.
Walter S. Chrysler, Weiser, Idaho.
H. M. Achim, Aurora, Illinois.
S. S. Scott, Galesburg, Illinois.
U. F. Turpin, Niles Center, Illinois.
Henry P. Brock, Peru, Illinois.
Allen R. Boudinot, Silvis, Illinois.
Lester Swain, Woodstock, Illinois.
Alfred Krause, Brookville, Indiana.
Joseph Steiner, East Chicago, Indiana.
Charles E. Day, Evansville, Indiana.
Frank J. Miller, Mishawaka, Indiana.
Rollan H. Sutherly, Peru, Indiana.
Keith C. Cawood, Shelbyville, Indiana.
Worth N. Yodev, Tipton, Indiana.
C. J. Anderson, Marshalltown, Iowa.
Keyes C. Gaynor, Sioux City, Iowa.
Truman Schlup, Kansas City, Kansas.
Leo Meyers, Larned, Kansas.
L. W. Chambers, Osawatomie, Kansas.
J. H. Vincent, Pittsburgh, Kansas.
J. R. Kinsella, Newport, Kentucky.
Harold S. Crocker, Brockton, Mass.
Walter J. Love, Canton, Massachusetts.
Harry W. Bailey, Haverhill, Mass.
Thomas W. Sheehan, Malden, Mass.
John R. Kleindienst, Webster, Mass.
Sidney D. Strong, Oak Park, Michigan (P. O. Ferndale)
Frank J. Brince, Eveleth, Minnesota.
R. S. Myers, Oxford, Mississippi.
L. A. Pelty, Farmington, Missouri.
Orvid J. Holtman, Mexico, Missouri.
J. F. Kilpatrick, Rolla, Missouri.
Hugh D. McGaw, Hastings, Nebraska.
Alfred E. Riley, Hamilton, New Jersey (P. O. Trenton)
A. O. West, Batavia, New York.
Fred H. Durfre, Gloversville, N. Y.
James G. Norton, Kingston, New York.
John J. Dunne, Mount Kisco, N. Y.
A. J. Kaufman, Rensselaer, New York.
Don H. Andrews, Salamanca, N. Y.
W. F. Weaver, Asheville, N. C.
J. A. Loughlin, Wilmington, N. C.
Geo. A. Swenson, City Commissioner, Wahpeton, North Dakota.
F. F. Wright, Bellefontaine, Ohio.
J. F. Cupp, Lima, Ohio.
Thos. J. Farrell, Marietta, Ohio.
Frayne Combs, Wapakoneta, Ohio.
Ralph W. O'Neill, Youngstown, Ohio.
Loren T. McKee, Enid, Oklahoma.
J. N. Gearhart, Coquille, Oregon.
Ben S. Morrow, Portland, Oregon.
W. S. Tanner, Bryan, Texas.

J. C. Bisset, Corpus Christi, Texas.
Oran J. Payne, Pampa, Texas.
D. R. Donahue, Montpelier, Vermont.
M. E. Haug, Portsmouth, Virginia.
Jay E. Henry, Wheeling, West Virginia.
Lloyd L. Jensen, Elkhorn, Wisconsin.

The following have been appointed Water Works Superintendents:

H. J. Parsons, Alexandria City, Ala.
L. C. McClurkin, Helena, Arkansas.
Earl Pleasenton, Dover, Delaware.
A. D. Hudson, Gainesville, Florida.
R. E. Baker, Leesburg, Florida.
J. L. Sweeney, Pensacola, Florida.
R. M. Johnson, St. Augustine, Florida.
L. K. Rapp, Nampa, Idaho.
B. W. Cullen, Chicago, Illinois.
H. M. Ely, Danville, Illinois.
Herbert F. Hann, Forest Park, Illinois.
G. Leland Watson, Lake Forest, Illinois.
Peter Conrad, Niles Center, Illinois.
Logan Crafton, Bloomington, Indiana.
Lloyd Thomas, Mount Vernon, Indiana.
Wm. C. Shoemaker, Richmond, Indiana.
S. W. Jorgensen, Indianola, Iowa.
J. Milton Conrow, Sibley, Iowa.
Clint B. Rankin, Pittsburgh, Kansas.
W. S. Bronson, Madisonville, Kentucky.
Daniel T. Ryon, Brockton, Massachusetts.
William Graves, Marblehead, Massachusetts.
Walter Messick, Austin, Minnesota.
H. E. Springer, (Acting), Chisholm, Minnesota.
Herman Donnay, Glencoe, Minnesota.
H. B. Newman, Cape Girardeau, Missouri.
James Wolfenden, Neosho, Missouri.
Walter Burn, Omaha, Nebraska.
Arthur A. Wallace, Keene, New Hampshire.
Carl Kidd, Dansville, New York.
Chas. H. Banks, Superintendent Department Public Service, Niagara Falls, New York.
R. L. Maynard, Asheville, North Carolina.
T. L. Gordon, Morganton, North Carolina.
Martin S. Petersen, Girard, Ohio.
Ralph Birt, Greenville, Ohio.
Royal Keyes, Public Works Director, Newark, Ohio.
J. H. Trainer, Steubenville, Ohio.
W. R. Schnabel, Allentown, Pennsylvania.
Fred Arensburg, Brownsville, Pennsylvania.
Harry Bechtold, Lebanon, Pennsylvania.
H. W. Austin, Nanty-Glo, Pennsylvania.
J. A. Stromme, Madison, South Dakota.
J. M. Cresnell, Milan, Tennessee.
J. W. Cunningham, Corpus Christi, Texas.
Chas. Langston, Mission, Texas.

The following County Engineers have been appointed:

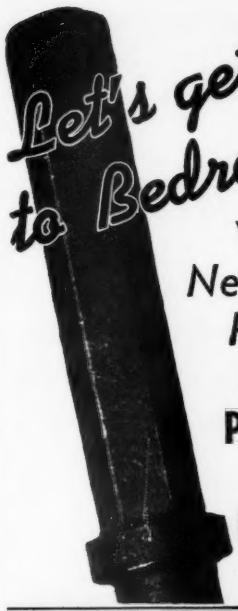
A. H. Randall, Navajo County, Holbrook, Arizona.
A. D. Munden, Kern County, Bakersfield, California.
Heber Scamalorn, Spencer County, Rockport, Indiana.
James H. Pullan, Taylor County, Bedford, Iowa.
A. M. Hovey, Mahaska County, Oskaloosa, Iowa.
Henry C. Lamb, Calhoun County, Rockwell City, Iowa.
Frank Anderson, Cheyenne County, St. Francis, Kansas.
Glenn H. Conard, Hamilton County, Syracuse, Kansas.
Frank N. Smith, Montmorency County, Atlanta, Michigan.
L. E. West, Barry County, Hastings, Michigan.
Harold J. Rich, Schoolcraft County, Manistique, Michigan.
John S. Schmit, Stearns County, St. Cloud, Minnesota.
Hugh Wilson, Lewis County, Monticello, Missouri.
H. L. Watehous, Platte County, Platte City, Missouri.
John Ryan, Atchison County, Rock Port, Missouri.
Leonard J. Leise, Cedar County, Hartington, Nebraska.
Gerald M. Roos, Thayer County, Hebron, Nebraska.
C. E. Habiger, Colfax County, Eagle Nest, New Mexico.
J. W. Harty, Grand Forks County, Grand Forks, North Dakota.
Gilbert N. McQuern, Tama County, Toledo, Ohio.
Gus A. Mills, Cherokee County, Tahlequah, Oklahoma.
J. A. Tuscher, McPherson County, Leola, South Dakota.
A. G. Ruff, Cameron County, Brownsville, Texas.
A. J. Needham, Jr., Coleman County, Coleman, Texas.
Lee Thompson, Parmer County, Farwell, Texas.
W. W. Coym, Karns County, Kansas City, Texas.
C. W. Carter, Pend Oreille County, Newport, Washington.
C. J. Irish, Forest County, Crandon, Wisconsin.
Ben Bradford, Dunn County, Menominee, Wisconsin.
J. A. Clark, Marathon County, Wausau, Wisconsin.

Hugh M. Corrough has been appointed manager of the Alco Products Division of the American Locomotive Co.

George R. Huffman, for the past three years advertising manager of R. G. LeTourneau, Inc., Peoria, Ill., has resigned to return to the Pacific Coast.

John J. Rockefeller, former Public Works Administration Engineer, has been appointed promotion engineer for the Clay Sewer Pipe Association, Inc., Pittsburgh, Pa.

William H. Cullimore has been appointed engineer and secretary of the National Paving Brick Ass'n. He takes the place of the late George Schlesinger. Mr. Cullimore has been associate engineer of the Department of Public Works of Baltimore, Md.



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5. How you can convert an ordinary Ford model A or B motor into an air compressor for operating jackhammers, paving breakers, clay spaders, tampers, paint sprays, etc., is explained in a new bulletin just issued by Gordon Smith & Co., Desk G, 516—10th St., Bowling Green, Ky.

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42d St., New York, N. Y.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Dirt Moving Efficiency

65. "Dirt Moving," is a new 32 page booklet illustrating the use of Trac Tractors as a source of money-making power for bulldozers, bullgraders, wheel scrapers, fresnos, graders, dump wagons, tampers, etc. 24 pages of action pictures, directions, etc. Sent promptly by Internaional Harvester Co., 180 No. Michigan Ave., Chicago, Ill.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches—for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Brick

116. Standard specifications for vitrified brick pavements and brick parking strips and gutters, as adopted by the American Society of Municipal Engineers. Also standard specifications for bituminous filled brick pavements adopted by the American Association of State Highway officials. If you contemplate using brick for paving, you should have a set. National Paving Brick Ass'n, Washington, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from 1½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3341 No. Palmer St., Milwaukee, Wis.

125. Homelite portable, self-priming, centrifugal pumps in sizes from 2" to 3" are fully described and illustrated in new folders. Homelite Corp., 2404 Riverdale Ave., Portchester, N. Y.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Drainage Products Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

Road Building and Maintenance

127. See road work as it was done in the 1890's and as it can be done by a full line of this year's road building equipment. See, in this new action picture book, the first reversible roller, 1893 World's Fair Award Grader and how methods have changed. Attractive new booklet AD-1796 recently issued by The Austin-Western Road Machinery Co., Aurora, Ill.

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalog 200 issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

129. New bulletins illustrate and describe the latest line of Littleford Utility Spray Tanks, Traf-O-Liners, Street Flushers and Kettles. Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

130. Illustrated literature (No. 4001) gives full specifications and advantages of Warco Motor Graders. Includes detail photos of special features. W. A. Riddell Corp., Bucyrus, Ohio.

Rock Breaker

131. Atlantic Pneumatic Rock Breaker. Folder fully describing and illustrating this new improved tool for splitting rock fast without explosives. Atlantic Steel Co., 1775 Broadway, New York.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3846 No. Palmer St., Milwaukee, Wis.

137. New bulletin describing in detail the new Huber Road Rollers will be sent promptly on request by the Huber Mfg. Co., Marion, Ohio.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

Shovels, Cranes and Excavators

144. New illustrated catalog gives full details about Bucyrus-Erie 10-B full-revolving, versatile, money-saving ⅜ yd. shovel for cities and counties. Issued by Bucyrus-Erie Co., South Milwaukee, Wis.

145. The Austin-Western-Badger, a fully convertible ½ yard crawler shovel, made by The Austin-Western Road Machinery Co., No. A-5 Aurora, Ill., is fully described and illustrated in their Bulletin No. AD-1683.

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